SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1910.

GENERAL PHYSICS.

641. *Time Comparisons by Radiotelegraphic Signals.* **Claude, Ferrié, and Driencourt.** (Comptes Rendus, 150. pp. 806–809, Feb. 7, 1910.)—In 1904–05 Albrecht showed that it was possible to utilise wireless telegraphy for the transmission of time signals in the determination of terrestrial longitudes. In 1906 E. Guyon found it possible to work between Paris and Brest by the method of *telephonic coincidences* with an accuracy of 0·008 sec. under good conditions. With an apparatus installed between the observatories of Paris and Montsouris, a series of comparisons were made between the results given by telephonic and radiotelegraphic transmission, and the probable errors show the mean error of a comparison to be about ±0·0006 sec. A set of pendulums with special silver contacts were employed to work the sparking apparatus for the wireless signals. C. P. B.

642. *Seismic Observations with Liquid Accelerometers.* **E. Oddone.** (Accad. Lincei, Atti, 19. pp. 277–288, March 6, 1910.)—The author shows that the theory on which Lo Surdo's apparatus [Abstracts Nos. 229 and 514 (1910)] is based, is erroneous, an increase of the ratio of the sections of the tubes not reducing the period without diminishing the sensibility. If the period of the ground's motion is less than that of the system, too low results will be obtained, and if higher than that of the system the results will be excessive. Examples are given of the two cases, the results being only one-half, and nine times as great as they should be respectively. W. H. St.

643. *Behaviour of Ductile Material under Torsional Strain with Restoration of Elasticity at Low Temperatures.* **C. E. Larard.** (Inst. Civ. Engin., Proc. 179. pp. 832–845, 1910.)—Contains a detailed account of experiments on mild steel. The test-piece, 2·95 in. diam., was secured to dies of testing machine by two keys at each end. Autographic torque-twist diagrams are shown. The material was annealed before test. The primary elastic limit was reached

at 59,000 in.-lbs. torque. Sudden plastic yield occurred at 86,000 in.-lbs. The strain at the latter torque was eight times the total elastic strain recorded up to elastic limit. At torque of 120,000 in.-lbs. the total twist was 26·2°. The load was then slowly removed, the specimen placed in hot-air bath (temp. 200° C.) for 2 hours, then taken out and 16 hours' rest allowed. On reloading, it was found that the result of heat treatment and rest was to restore complete elasticity of material. [This result of heat treatment at low temperature for torsion tests confirms experiments by L. P. Parker, Junior Inst. Engin., Journ., 1908.] Heat treatment and rest was repeated several times on this specimen. The author concludes that the max. working stress can be raised by strain and heat treatment. From the figures given the *plastic* work increases about proportionally with the twist when the test is well forward. Comparing the work required to produce fracture and the elastic resilience up to the primary elastic limit, the ratio of the two quantities is about 1 : 16,400. The total work necessary to fracture the specimen subjected to step-by-step heat-treatment was 50 per cent. more than that required to fracture specimens of same material tested continuously and fairly quickly. Various interesting phenomena, showing local straining, were noticed. Six straight generating lines were painted and scribed on specimens before the test. Up to a certain load the helical lines indicated uniform pitch. As the twist increased, the general twist over the whole specimen was arrested and commenced locally over about 4 in. from one end, the helical lines in that region closing up rapidly as new local twist increased, adjacent sections seeming literally to rotate one over the other at a great rate. Some alteration in the dimensions of the specimen was noted. The final elongation was 0·185 in. on a length of 12·06 in., and the reduction in diam. at max. torque was 0·0185 in.

C. A. M. S.

844. ***Change of State in Metals under Mechanical Strain.*** **A. Martens.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 11. pp. 209–220, 1910.)—The author opens with a general discussion of the manner in which what he terms the "characteristics" of the material (*i.e.*, yield-point, max. stress, breaking stress, and elongation at fracture denoted respectively by σ_s, σ_b, σ_u, and E_s) are affected by various treatments. The case of wrought iron is taken, and three stress-strain curves are given showing tests on original "bloom," after further puddling and heat treatment, and after cold hammering. With cold-working σ_b, σ_u, and $\frac{\sigma_s}{\sigma_b}$ increase, whereas E_s decreases. The effect of annealing after cold working is also shown by a characteristic curve. The work done to produce fracture is next considered. The general law connecting the various curves is: (work done on specimen per cm.^{3})/σ_s E_s = const., which he denotes by ξ. Considering the effect of time, the author points out that although stress is instantaneous the strain may go on for months—a property probably connected with the internal friction. This property of "afterflow" also affects the stress-strain curves obtained by different rates of loading. Three curves are given to illustrate this point, and the author insists on the importance of this phenomenon. In some metals the effect is much more marked than in others. Thus the breaking stress of zinc can be raised 50 per cent. by rapid loading, while iron can only be affected to the extent of 1½ per cent. with difficulty. Bauschinger has shown that strain will continue for very long periods, the effect increasing with increasing load. The yield-point can be raised by time, also by overstrain and annealing. The author points out that until the time-effect, and indeed all changes of state, are thoroughly investigated, the

so-called "factor of safety" cannot be placed on a rational basis. With regard to repetition of stresses he briefly mentions the work of Albert, Fairbairn, Wöhler, and Autenheimer. In connection with his own work on this subject an instructive curve is given showing the relation between the number of repetitions (beyond elastic limit) and the resulting extension. It is shown that over 80 per cent. of the final elongation is proportional to the number of repetitions of stress. Taking the instructive case of magnesium as an example of time-effect three curves are given by way of illustration. The first is a stress-strain curve in which the load was kept constant for 5 min. at each increase of load: it is interesting to note that a slow contraction takes place when the load is reduced. A second curve shows the relation between load and increase of extension for each minute of time-effect. A third set of curves show how the rate of extension with constant load decreases with time. The latter curves are not regular, but a mean curve approximates to an hyperbola. A method is suggested by which the extension with time-effect could be obtained by a kind of kinematographic apparatus—a machine on which he hopes to be able to carry out experiments in the near future. C. A. M. S.

645. *Tests on Metals by Study of the Damping of Vibrations.* **O. Boudouard.** (Comptes Rendus, 150. pp. 696–698, March 14, 1910.)—The above method of studying the properties of iron and steel was first suggested by A. Guillet [Abstract No. 1909 (1909)], and its importance having been insisted upon by H. le Chatelier the question has been taken up by the author. Briefly the apparatus consists of a bar fixed in a kind of vice which is in turn firmly attached to a rigid table. Vibrations of the bar are started and maintained by an electromagnetic device working on a slide by which it can be brought up close to the bar. The extremity of the bar carries a mirror by which a photographic record of the vibrations and damping when the current is switched off can be obtained. The material used was a good quality commercial steel containing 0·8 per cent. carbon. The angular vibrations were through an angle of about 6° to 7°, representing a movement at the free end of the bar of 3, 4, and 5 cm. The bar was tested in its commercially rolled condition, annealed, and tempered. In the first condition the specimen was fractured in 12 hours 30 min., representing about 1,350,000 vibrations. In the second case it broke in 4 hours 30 min. (about 486,000 vibrations), and in the third case after 30 min. (about 54,000 vibrations). An examination of the fracture showed parallel zones with varying size of grain. This is a point requiring further investigation. The photographic records do not appear to have given much information except in the case of the tempered material, where it appears that no important molecular changes take place before rupture. The results appear to have been such as to encourage the author to make a fuller study of the whole matter. C. A. M. S.

646. *Flow of Water through Converging or Diverging Pipes.* **A. H. Gibson.** (Roy. Soc., Proc. Ser. A. 83. pp. 366–378, March 2, 1910.)—Twenty-five pipes were used in these experiments, being all carefully made of wood and finished off with shellac varnish. The chief conclusions drawn may be summarised as follows: (1) In a circular pipe with uniformly diverging boundaries the total loss of head attains its minimum value with a value of the vertical angle θ equal to about 5° 30′. As θ is increased the loss of head expressed as a percentage of $(v_1 - v_2)^2/2g$ increases very rapidly from its minimum value of about 18·5 per cent. to a maximum of about 121 per cent. when $\theta = 68°$

afterwards diminishing to about 10·2 per cent. as θ increases to 180°. (2) By making the pipe trumpet-shaped so as to make dv/dx uniform throughout the pipe the loss is in some cases increased, in others diminished. Only one such circular pipe was used, and here the loss was 28·5 per cent., as against 17·8 per cent. in a straight taper pipe of the same length and having $\theta = 10°$. In the case of rectangular pipes, however, those having boundaries curved so as to make respectively dv/dt = const. and dv/dx = const., showed that the loss as compared with that in the corresponding straight taper pipe ($\theta = 20°$) was reduced respectively by 5·8 and 12·1 per cent. Further experiments are needed to determine the precise form of curve giving least loss of head in each case. (3) The loss of head in a pipe of square section is greater (by at least 20 per cent.) than in a circular diverging pipe of the same length and same initial and final areas, while the minimum loss is apparently obtained when the angle between opposite faces of the pipe is approximately 4°. (4) A change of shape, as opposed to the area, of the cross-section of a pipe leads to considerable loss of head. Thus by changing the section of a pipe from that of a square of 2·66 in. side to a rectangle 1·33 × 5·32 in. in a length of 9·94 in., a loss of head equal to $0·484\ v^2/2g$ was experienced. (5) Where a rectangular pipe has one pair of sides parallel and the second pair uniformly diverging the loss of head is much greater than in a circular pipe having the same length and the same initial and final areas. The minimum loss was obtained with θ = about 11°. (6) The critical velocity of flow in a circular pipe with uniformly converging boundaries is much greater than in a parallel pipe of the same mean diam. The critical velocity increases rapidly with the angle of convergence, its lower value in pipes from 8 in. to 1¼ in. diam. at 57·5° F. and for the parallel pipe being as follows where the diam. is 2¼ in. :—

θ	0°	5°	7·5°	10°	15°
Critical velocity in ft. sec.$^{-1}$	0·138	2·7	3·4	4·8	5·7

E. H. B.

647. *Eddy Formation.* **G. H. Bryan.** (Nature, 82. pp. 408–409, Feb. 8, 1910.)—A discussion of the formation of eddies in the wake of projecting obstacles. Consider a stream bounded by and moving parallel to the plane OX, with velocity U, and containing a stationary vortex at A (a,b), or, what is the same thing, an unbounded fluid containing a stationary vortex pair at $(a \pm b)$. With the notation $w = \phi + i\psi$, $z = x + iy$, ϕ = velocity potential, ψ = stream function, the potential function is given for this case by $w = U\left[z + 2ib \log \{(z - a - ib)/(z - a + ib)\}\right]$. Inside a certain surface OQP, the stream lines are closed curves and the motion is cyclic; outside, the fluid streams past the surface as if it were a solid obstacle, as is well known. If the bounding surface meets the plane boundary OP at O, and O is the origin, then $dw/dz = 0$ when $z = 0$, whence $a = b\sqrt{8}$ in the above expression. Now substitute $z = \sqrt{z'}$ and the solution is obtained of a *continuous* motion round the straight edge past O, with a single vortex in the dead water in the wake of the edge. With $z' = z'^n$ we get a streaming motion round a rectangular corner with a single vortex in the dead water, and similarly with $z' = z^n$, where $1 < n < 2$, we get a streaming motion past a projecting corner with re-entrant angle $n\pi$. Except in the case $n = 2$, when the velocity is finite, the velocity at the origin is zero; further, the stream line bounding the dead water makes equal angles with the two parts of the fixed boundary; thus, for the case $n = 3/2$ the boundary of the dead water starts from the origin at an angle of 135° with the two walls, and the dead water projects forward

into the stream. The author believes he has seen something of this kind when a stream flows through the arches of a bridge, the circulating fluid pushing the stream into the centre and narrowing it. Similar results for the case of eddy formation in the wake of a lamina at right angles to the stream are obtained by applying Schwarz and Christoffel's transformation. The author has seen nothing like these solutions, but even if they are not new it seems desirable that attention should be directed to them in view of the importance which such problems have assumed in connection with aerial and other navigation. A. W.

648. *Temperature-coefficients of Gas Viscosity.* IV. *Apparent Relation between Viscosity and Specific Heat.* **W. J. Fisher.** (Phys. Rev. 29. pp. 147–158, Aug., 1909.)—In the series of straight lines representing the relations between viscosity and temperature for a number of compound gases [see Abstracts Nos. 1168 (1907) and 661 (1909)], it is found that the abscissa intercepts increase in an order which is the reverse of the order of the specific heat ratio, $\gamma = C_p/C_v$. This relation, which also applies to the elements—argon and hydrogen being exceptions—either indicates a new gas-law connecting the viscosity with the complexity of the molecule, or is a result of approximation made in order to simplify the mathematical treatment of the gas-flow in a capillary tube. The recent work of Ruckes [Abstract No. 1042 (1908)] on the critical velocity of gases flowing in long, narrow tubes, indicates that there is a decided fall of temperature in the gas, especially near the exit end. The author studies the problem, assuming $pv^n = k$ as the equation of expansion, and making also certain assumptions as to slip on the walls, cylindrical flow, &c.; the resulting equation is $F = \pi a^4(1 + 4\zeta/a)(p_1^{1+1/n} - p_2^{1+1/n})/[8\eta l p^{1/n}(1 + 1/n)]$, in which F is the volume of gas passing per sec., measured at pressure p, a is the radius, and l the length of the tube, ζ the slip coefficient, p_1 and p_2 the entrance and exit pressures respectively, and k and n are assumed constant. If $n = \infty$, the equation $pv^n = k$ represents an incompressible liquid, since then $dp/dv = 0$, and the flow equation reduces to the well-known form of Poiseuille—

$$F = \pi a^4(1 + 4\zeta/a)(p_1 - p_2)/8\eta l \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1).$$

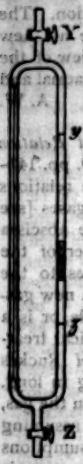
If $n = C_p/C_v$, the ratio of the two specific heats of a gas, the equation implies adiabatic expansion throughout the tube, conductivity of heat through the capillary walls or the gas and frictional production of heat in the gas both being excluded. This is evidently a limiting case; n cannot be as great as C_p/C_v. Any introduction of heat into the gas will tend to diminish n. If $n = 1$, $pv = \text{const.}$, and the flow equation reduces to—

$$F = \pi a^4(1 + 4\zeta/a)(p_1^2 - p_2^2)/16\eta l p \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2),$$

which is the equation of O. E. Meyer (Pogg. Ann. 127. p. 269, 1866), and implies perfect conductivity of both gas and walls, and that the latter are kept at a constant temperature; this is also a limiting case, and n cannot be as small as unity. Assuming that the production of heat by internal friction is too small to change the conditions of flow materially, then the value of n, while probably not the same for all points in the tube, must remain between 1 and C_p/C_v, and the true equation of flow lies probably somewhere between the equations (1) and (2). The difficulty of integrating the equations of the capillary tube could be avoided by an apparatus constructed on the plan of that used by Helmholtz and Piotrowsky (Helmholtz, Abhandlungen, i., p. 196),

or that of Zemplén [Abstract No. 838 (1906)] or that of Hogg [Abstract No. 1882 (1905)], all of which depend on the Helmholtz solution of the problem of a sphere vibrating in or about a viscous fluid. Such an apparatus used in the study of two gases of considerably different complexity, such as air or nitrogen and methyl chloride, would give a check on the capillary tube method. The nearest approach to such a check is found in the agreement between Breitenbach's capillary tubes with those of Puluj [Abstract No. 775 (1899)].

T. H. P.



649. *Method of determining the Viscosity of Gases, especially those Available only in Small Quantities.* **A. O. Rankine.** (Roy. Soc., Proc. Ser. A. 83. pp. 265–276, Feb. 10, 1910.)—The author has devised an apparatus in which the viscosity of gases can be easily determined, and which is specially suitable for gases which can only be had in small amount. It is shown in the Fig. One limb of the tube is formed by a fine capillary, while the other is chosen very wide in comparison, the width being as large as possible compatible with an intact fall of a globule of mercury. The method of carrying out a determination was to allow the drop of mercury to fall in the wider tube, and to note the time of fall between the two marks *y* and *z*. The tube was then inverted, and the time of fall between the two marks again ascertained. The theory and practical manipulation of the apparatus are discussed.

A. F.

650. *Climate of Tripoli in Berbery.* **P. Martinuzzi and F. Eredia.** (Annal. Uffic. Centr. Meteorol. 30. I. Rome, 1909. Extract by **J. Hann.** Meteorolog. Zeitschr. 27. pp. 81–88, Feb., 1910.)—The observations, taken at the Scuola Tecnico-commerciale, cover the period 1892–1907, but are not quite continuous; Hann analyses also some previous records. The annual means are: Barometer, 760·4; temperature, 19·7° C. (mean annual extremes, 8·9 and 40·2° C.); humidity, 12·1 mm. (65 per cent.); rainfall, 439 mm.; thunderstorm days, 8·4; rain days, 51·5. The data are compared to Sicily (and also to Southern Italy). Tripoli is about 1° C. warmer than Sicily, especially in winter; the temperature exceeded 40° C. eleven times in 15 years, but this maximum never fell in Aug., the hottest month; the humidity is about the same as in Sicily, and is little influenced by the season; autumn is the driest season; the greatest amount of rain, 180 mm., fell on a February day, 1897. Southerly winds bring dry weather and much dust.

H. B.

651. *Observations of Cloud Motion at Samoa.* **G. Angenheister.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 363–370, 1909.)—Observations of cloud motion were made at Samoa Observatory, lat. 13·5° S., from April, 1907, to the end of 1908. Clouds are grouped into: upper clouds, Ci, Ci-St, and Ci-Cu, height exceeding 6·5 km.; intermediate clouds, A-Cu, A-St, height 2·5–6·5 km.; lower clouds, Cu, Fr-Cu, Fr-Nb, St, below 2·5 km. The year may be divided into two seasons: the wet, Nov.–April; the dry, May–Oct. The upper clouds always have a component from west; the mean direction for the dry season was W. 37° N., for the wet W. 8° N. In intermediate layers a component from north predominates, the mean directions were: dry season, N. 42° E.; wet season, N. 18° E. The motion of the lower

clouds is complicated, as these clouds are occasionally drawn into the surface circulation of thunderstorms or of land and sea breezes caused by the island itself. Neglecting such local variations, and confining ourselves to lower clouds floating in the trade-wind circulation, the mean directions are: dry season, E. 0·5° S.; wet season, N. 46° E. The mean surface winds at sea (from ships' logs) are: E. 45° S. in the dry season; N. 67° E. in the wet season. The surface circulation of the S.E. trade at Samoa is not a regular one as in corresponding latitudes in the S. Atlantic (St. Helena 16° S.). Thus for the first half of Aug., 1907, the weather was almost cloudless, with only occasional Cu from W. The surface currents varied between westerly breezes and the S.E. trade wind, which is usually very regular in Aug. Westerly winds were general in this month over a large area of the Pacific, usually under the influence of the S.E. trade wind in the month of August. R. G. K. L.

852. *Vertical Temperature Gradients over Lindenberg in 1908.* **A. Peppler.** (Meteorolog. Zeitschr. 27. pp. 83–87, Feb., 1910.)—The author analyses the records for 1908 from Lindenberg, near Berlin, where balloons have been sent up since 1902 every day, without any interruption, mostly between 7 and 10 a.m., up to heights of 8500 m., and sometimes to 9000 m. Observations are secured at intervals of 500 m.; Lindenberg is situated 122 m. above sea-level. The results are grouped with regard to six different relative positions of cyclones and anticyclones, and with regard to winter (Sept. to Feb.) and summer (March to Aug.); in March and Sept. the gradients change noticeably, especially in the lower strata. Inversions are observed only in the lower 1000 m., and especially in the winter; in summer any inversions formed tend to disappear. The front of a cyclone is, in summer, frequently the hearth of thunderstorms, and in such cases an inversion is common in the lowest strata. A further study of the problem would require observations in steps of 100 m. instead of 500 m.; but the author does not consider the determination of the vertical gradients as very promising for forecasts. H. B.

853. *Polarisation of Sky Light.* **H. H. Kimball.** (Mount Weather Observatory, Bull. 2. 2. pp. 55–65, 1909.)—Observations were confined to cloudless days. The sources of illumination of the sky are considered to be (*a*) the scattering of light by particles in the atmosphere whose diameters are small as compared with the wave-length of light, (*b*) the scattering by relatively large particles, (*c*) the reflection of light from the surface of the earth. At the point of polarisation, *i.e.*, the point in a plane through the sun and the zenith at zenith distance equal to the complement of the sun's zenith distance, the component depending on (*a*) is polarised, while the components depending on (*b*) and (*c*) are, in effect, unpolarised. The observations, made with a Pickering polarimeter, determined the ratio of (*a*) at the point of max. polarisation to the total sky illumination. (1) When the ground is covered with snow there is a marked decrease in the percentage of polarisation, due to increased reflection from the surface of the earth. (2) There is a diurnal variation in the percentage of polarisation, the minimum occurring at noon, with a gradual increase as the sun approaches the horizon, and a marked increase during the first few minutes of twilight following sunset, which may be attributed to relatively less reflection from the ground than from the particles in the atmosphere as the zenith distance of the sun increases. (3) The last part of the paper attempts to find a connection between the percentage of polarisation and the general absorption of the atmosphere

as determined from simultaneous pyrheliometer observations made at different levels. The percentage of polarisation decreases as the general absorption increases, but apparently not according to a simple law.

R. G. K. L.

654. *Influence of Variations of Solar Phenomena on Terrestrial Meteorology.* **R. Merecki.** (Meteorolog. Zeitschr. 27. pp. 49–61, Feb., 1910.)—The record of a barograph or thermograph may be looked upon as a series of waves of unequal amplitude and length. If a_p be the amplitude of a positive variation above the normal, and a_n the corresponding value for a variation below the normal, the expression $(\Sigma a_p + \Sigma a_n)$, taken irrespective of sign, gives a measure the steadiness of the curve. In a previous paper the author has determined this function for successive years for the pressure data for Warsaw and a few other stations, and has compared the results with Wolf's sun-spot numbers. He found a suggestion that the maxima and minima of the sun-spot curve are associated with large values of $(a_p + a_n)$. In the present paper he has applied the same method of investigation to temperature data. He deals separately with eleven widely separated regions on the earth's surface, each region being represented by a number of stations, for many of which data are available from 1828 onwards. He finds a distinct tendency for high values of $(a_p + a_n)$ to occur in the same years in all parts of the world, indicating the general prevalence in particular years of variable weather conditions. As a general rule these years of max. $(a_p + a_n)$ are coincident with, or follow or precede, years of sun-spot maximum or minimum.

R. G. K. L.

655. *Bishop's Ring and other Optical Phenomena in* 1907–1909. **F. Busch.** (Meteorolog. Zeitschr. 27. pp. 61–65, Feb., 1910.)—Systematic watch was kept at Arnsberg during the years stated for the occurrence of Bishop's ring. At the same time the intensity of the blue of the sky and of the purple afterglow was estimated on all evenings suitable for the purpose. The intensity of the phenomena was noted on a scale of seven steps, ranging from 0.5 to 3·5. From May, 1907, onward increased intensity was noted in all the optical phenomena; the max. intensity occurred in Sept. and Oct., and it was not until Jan., 1908, that the phenomena became normal again. Bishop's ring was seen on Sept. 27, Oct. 20, 1907, and Jan. 2, 1908, with the sun high in the heavens. In June, 1908, a further increase of intensity of optical phenomena was again noted. Bishop's ring was again seen on June 25, 28, and 30, during the day. The phenomena did not diminish in intensity until the winter of 1908–9. Bishop's ring has not been seen since early in Feb., 1909.

R. G. K. L.

656. *Long-period Deviations of Horizontal Pendulum.* **B. M. Varney.** (Science, 31. pp. 280–282, Feb. 11, 1910.)—The work of Omori, Milne, Denison, and others on the movements of horizontal pendulums due to other than seismic or microseismic causes suggested an investigation of the movements of the pair of Bosch-Omori instruments at the Harvard seismographic station, taking the records for April, May, Oct., Nov., and Dec., 1908. Two types of deflection were investigated for each of the components E-W. and N-S., and the results appear to suggest a connection with the variations of barometric pressure. The movements of the pendulums show greatest response during the autumn and winter months, and these seasons are those in which barometric maxima and minima are best developed. The possi-

bility of using horizontal pendulums in forecasting on windward coasts has been suggested, and if it can be proved that such indications are given in advance of the barometer, the method may prove valuable. C. P. B.

657. *Current Observations in Loch Garry.* **E. M. Wedderburn.** (Roy. Soc. Edinburgh, Proc. 30. pp. 812–828, 1909–1910.)—The observations conducted by the author and W. Macdonald in Loch Garry, 4 miles long, 220 ft. max. depth, confirm on the whole those made in Loch Ness [see Abstract No. 2002 (1909)] with the same instruments. The direction and the strength of the water currents varied very much. Only with moderate winds were the water currents uniform. High winds do not necessarily mean strong currents, except, of course, at the surface. Owing to the great variability in the currents, simultaneous observations with several current-meters would be desirable. H. B.

658. *Isogeotherms under Mountain Ranges in Radio-active Districts.* **C. H. Lees.** (Roy. Soc., Proc. Ser. A. 83. pp. 339–346, March 2, 1910.)—The shapes of isogeotherms under and in the neighbourhood of a mountain range are deduced on certain assumptions, the chief of which are: (1) The range is of uniform height and width, and is long in comparison with these dimensions; (2) the radio-activity and thermal conductivity of the material of the range and of the earth's crust are the same. Diagrams are given of the isogeotherms corresponding to ranges of certain typical sections. The results obtained do not agree with Fisher's conclusions that the shape of the surface of the range has little effect on the temperature gradient, and that a mountain has solid roots beneath it projecting downwards into a substratum of molten rock. The small amount of radio-active matter in rocks is shown to influence the shapes of isogeotherms to only a very slight extent. A. D. R.

659. *Sun's Motion with respect to the Ether.* **C. V. Burton.** (Phil. Mag. 19. pp. 417–423, March, 1910. Paper read before the Physical Soc., Nov. 26, 1909.)—It has been suggested by various workers that the sun's velocity with respect to the ether could be deduced from the observed times of the eclipses of Jupiter's satellites. The problem assumes increased importance at the present time because of Kapteyn's discovery of the two principal star-drifts, and the material necessary for the computation will soon be available following the discussion by R. A. Sampson of the Harvard photometric observations of the eclipses of the satellites. The method of analysis is indicated, taking into account the three causes of error, (*a*) irregularity of Jupiter's surface, (*b*) uncertainty of actual epoch of eclipses, (*c*) error of observation of time of mid eclipse. As the residual effects it is hoped to detect depend on the direction of the line drawn from the earth to Jupiter, and will have in consequence a period of about 12 years, it is important for the present investigation that the Jovian system should be free from any influence having an approximately equal period. This matter has been inquired into, and it appears that no disturbing influence of this nature is to be anticipated. To arrive at some idea of the probable errors a hypothetical orbit is discussed, from which it appears that it is important to choose the co-ordinate axes with care, so as to avoid the component with largest probable error having too great an influence on the result. C. P. B.

660. *Solar Constant of Radiation.* **C. Bellia.** (N. Cimento, 19. pp. 85–104, Feb., 1910.)—The author reviews previous work on the subject, and

concludes that the more modern and rational methods, which take into account the complex problem of selective atmospheric absorption, all give values approximating fairly closely to 2·1 cals. per min. per cm.². The older methods, which indicated about 4 cals., are discredited. A new formula is deduced for the calculation of the constant, based on a combination of Pouillet's relation $dq = -qc\delta . ds$, where dq is the absorption exerted on an area ds, of density δ, and c is the coefficient of absorption, and Bemporad's equation $c = c_0\delta^k$, which shows that the coefficient of absorption along the path of an almost vertical ray is proportional to the 4th power of the density. Assuming the ray to make an angle z with the vertical, then the area traversed is $dh . \sec z$, so that $dq = -qc_0\delta^k . dh . \sec z$, and from Boyle's law $c_0\delta^k = kH^4$, therefore this becomes $dq = -k \sec z . qH^4 . dH$. Indicating by H the pressure at the place of observation, q the intensity of radiation observed, and A the intensity of radiation at the limit of the atmosphere, and integrating, this becomes—

$$\int_q^A dq/q = -k \sec z \int_H^0 H^4 . dH,$$

whence $\log q = \log A + H^5 \log p$, where $p = e^{-\frac{1}{5}k \sec z}$. This formula is applied to determinations of the solar constant for a large number of readings by the author and others at various altitudes. W. H. St.

661. *Comet Observation Programme.* **W. J. Humphreys.** (Science, 31. pp. 226–230, Feb. 11, 1910.)—A series of suggestions dealing with the types of observation which may be profitably followed when Halley's comet becomes sufficiently bright. These include photographs of the tail and head envelopes on large and small scale, spectrum observations of the comet, polarisation factor, and light-fluctuations. If the comet passes so near that the earth be enveloped in the tail, as is confidently expected, means should be taken to obtain records of electric potential, ionisation, conductivity, production of earth currents, &c., disturbances of the earth's magnetism, auroral displays, and variations of the intensity of the atmospheric absorption bands. Among the possible atmospheric phenomena may also be included meteor trails, sky-glows caused by fine particles, and luminous clouds. C. P. B.

662. *Astrophysical and Photographic Observations of Comet* 1910(*a*). **A. Ricco.** (Accad. Lincei, Atti, 19. pp. 260–264, March 6, 1910.)—Visual and photographic observations of the comet, made between Jan. 22 and Feb. 3, 1910, are described, showing that the visual image is practically the same as the photographic. This indicates that for this comet the principal radiations lie in that part of the spectrum capable of affecting both the human eye and a silver bromide photographic plate, viz., between the green and the violet. The changes in the spectrum of the comet [Abstract No. 880 (1910)] are due to the heat produced by the sun in its passage through perihelion. W. H. St.

663. *Times of Fall of Meteorites.* **O. C. Farrington.** (Amer. Journ. Sci. 29. pp. 211–215, March, 1910.)—A discussion is given of the times of fall of 850 meteorites with authenticated year and month, 827 with authenticated day, and 268 for which the time was recorded. Previous to the nineteenth century little record of a reliable nature is available; from 1860 to 1870 appears to have been the most prolific period since 1800. In the analysis of

the falls according to months, it would appear that they should bear some definite relation to the frequency of shooting stars, maxima of which occur in Aug. and Nov. It is found, however, that the months exhibiting the greatest number of falls are May and June. C. P. B.

REFERENCES.

664. *Tables of the Ber and Bei and Ker and Kei Functions, with further Formulæ for their Computation.* **H. G. Savidge.** (Phil. Mag. 19. pp. 49–58, Jan., 1910.)

665. *Thermal Molecular Pressure of Gases in Tubes and Porous Bodies.* **M. Knudsen.** (Ann. d. Physik, 31. 3. pp. 633–640, March 1, 1910.)—The author has shown previously [Ibid. 31. 1. p. 205, and Abstract No. 975 (1909)] that the pressure of a gas in a tube in which there is a temperature slope agrees with the expression $p_1/p_2 = \sqrt{(T_1/T_2)}$, when the diam. of the tube is vanishingly small compared with the mean free path of the molecule. The present communication contains the results of experiments which demonstrate more directly than before the correctness of the above expression. The transfusion tubes consisted of a plug of magnesia supported in a tube, heated electrically. A. F.

666. *Motion of Projectile after Penetration.* **K. Aichi.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 12. pp. 197–199, Jan., 1910.)—Remarks on Terada and Ōkōchi's Paper. [See Abstract No. 202 (1909).]

667. *Instantaneous Propagation of Disturbance in a Dispersive Medium.* **T. H. Havelock.** (Phil. Mag. 19. pp. 160–168, Jan., 1910. Paper read before the British Association at Winnipeg.)—Mathematical.

668. *Upper Air Temperatures Registered Outside and Inside Balloons.* **W. A. Harwood.** (Nature, 82. p. 366, Jan. 27, 1910.)

669. *Observations of the Aurora made at Yerkes Observatory, 1902–1909.* **E. E. Barnard.** (Astrophys. Journ. 31. pp. 208–233, April, 1910.)

LIGHT.

670. *New Stellar Spectroscope for Paris Observatory.* **M. Hamy.** (Comptes Rendus, 150. pp. 572–577, March 7, 1910.)—Stellar spectroscopy at Paris was practically discontinued about 1897, when certain of the instruments were removed to the Astrophysical Observatory at Meudon. To remedy this a very powerful spectrograph has been built, to be used in conjunction with the large equatorial Coudé of 0·60 m. aperture and 18 m. focal length. The instrument is of very novel design, chiefly with regard to stability; being quite separately supported, it has been made very massive, and is mounted on an altazimuth mounting to the north side of the telescope tube in the observing room. The total weight is about 1800 kg. The prisms are large, with faces 170 mm. long and 90 mm. high. The focal length of the Littrow type of collimator objective may be as much as 2·5 m. In order to avoid disturbing the adjustments of the focal plane of the equatorial, the primary image is not allowed to fall on the slit plate, but is projected on to it by a secondary magnifier. By the various combinations possible the dispersion may be varied from 40 mm. between H_β and K to an extreme of 158 mm. between λ464 and λ484. (The same interval occupies 112 mm. in the first order of a Rowland concave grating of 568 lines to the mm.) A difficulty is introduced owing to the long exposures necessary. For objects of sensible diam. a small camera chamber is provided of 0·4 m. focus, giving a dispersion of 85 mm. between H_β and K. The temperature control is aided by the massiveness of the parts; a large case of cast iron, 15 mm. thick, 3 m. long, 0·50 m. wide, and 0·25 m. deep, encloses a box of felted copper which contains the prisms. During a month the variation is not more than two or three hundredths of a degree. C. P. B

671. *Determination of Refractive Index by means of the Microscope.* **C. Viola.** (Accad. Lincei, Atti, 19. pp. 192–197, Feb. 20, 1910.)—It is shown mathematically that the error in determination of refractive indices by Clerici's method [Abstract No. 1029 (1909)], due to inaccurate measurement of the horizontal displacement by refraction, amounts to $\pm 0{\cdot}0086$. This may be greatly reduced by attaching a millimetre scale, divided into $\frac{1}{10}$ of a mm., just beneath the prism, when the method is fairly accurate. W. H. Si.

672. *Selective Radiation from Various Solids.* II. **W. W. Coblentz.** (Bureau of Standards, Bull. 6. pp. 801–819, Feb., 1910.)—In the case of solids investigated which have banded emission spectra, the distribution of intensities among the emission bands varies with rise in temperature. The distribution of energy seems to follow a law similar to that of a complete radiator in which the wave-length of max. intensity decreases with rise in temperature. Curves are given showing the relation between the emissivity and the wave-length for various minerals. Talc which was rendered incandescent on a heater tube, as in the previous experiments [Abstract No. 226 (1909)], gave three sharp emission bands at 2·42 μ, 2·75 μ, and 3·85 μ. At about 500° C. the band at 3·85 μ is as intense as the one at 5·4 μ, but at higher temperatures the bands at the lower wave-length become the more intense. By dehydration of the talc the maximum at 2·75 is shifted to 2·79. Several other

minerals are investigated, including topaz. Powdered topaz gives a maximum at 2·8 μ, whereas in the case of the rod of the substance previously examined the maximum was at 4·1 μ, although the temperature was 500–600 deg. higher. A mixture of the constituent oxides gave similar results to those obtained on the rod. This is strong evidence that at the higher temperature the rod must have been decomposed into the constituent oxides; further, that as the spectra appear to be composite of those of the individual oxides we probably have a solid solution instead of a chemical compound, since in a true compound the individuality of the spectra of the constituents is destroyed and an entirely new spectrum formed. The author then discusses the selective emission from metals, and describes experiments performed on carbon and tungsten lamps. He points out that it is not admissible to apply a "colour match" or even a bolometric test to one part of the spectrum and then attempt to draw conclusions as to what occurs in other spectral regions. The only way to be certain of one's results is to examine the spectrum from wave-length to wave-length throughout the whole range. For the full discussion of the selective emission of metal filament lamps the original paper should be consulted. W. C. S. P.

673. *Discontinuities in Light Emission.* **N. Campbell.** (Cambridge Phil. Soc., Proc. 15. No. 4. pp. 810–828, Jan. 31, 1910.)—This paper gives the account of an experiment which failed in the object aimed at, but it is thought that both the theory and method might prove of interest. According to all modern theories of radiation the emission of light is discontinuous in time. Whatever may be the nature of the radiators from which the light proceeds, there is little doubt that their vibration is not continuous. They are set into vibration by some external disturbance, such as the impact of electrons, and continue vibrating until the energy so acquired is dissipated by the damping due to radiation; they are then quiescent until the occurrence of a fresh disturbance. But there are at least two theories of radiation which suggest that light emission is discontinuous in space as well as in time. These theories were proposed by J. J. Thomson and by Planck. Taking Stark's interpretation of the latter, both theories suggest that the light from a single radiator is not emitted equally in all directions, but is concentrated along a finite number of narrow tubes radiating from the radiator: they also suggest that the energy emitted by such a radiator in virtue of a single disturbance is not infinitely divisible, but only divisible into a finite number of equal parcels, the magnitude of which, in Planck's view, depends on the frequency: further, this finite number is usually quite small under experimental conditions. Suppose, then, that by some means we can measure the intensity of a beam of light in such a way that the total intensity is the sum of the intensities of the radiations from the isolated radiators of which the source is composed. Let us split up the beam from a "single source" by one of the ordinary interference methods and measure in this way the difference in the intensity of the resulting beams, adjusting the arrangements so that the mean difference is zero. If the older theory of radiation is correct there is complete correlation between the "events" which constitute the two beams; when a radiator sends light into one beam it also sends it into the other. But, if the newer theory of the radiation is correct, the "events" are independent, or very nearly so, for in general each radiator sends its radiation into one beam and not into both. On the first theory the mean fluctuation of the difference should be zero: on the second the square of the mean fluctuation should be the sum of the squares of the fluctuations of either beam separately. Photo-

electric cells of Na-K alloy were used in the experimental work, but for the details of this and of the mathematical theory the original should be consulted. [See Abstract No. 1200 (1909).] E. H. B.

674. *Purkinje Phenomenon.* **C. Gallissot.** (Comptes Rendus, 150. pp. 594–596, March 7, 1910.)—Examination of the principal photometric catalogues indicates that in the estimation of stellar magnitudes systematic differences are presented depending on the brightness and colour of the stars. To obtain some definite measure of the effects possible on this supposition laboratory experiments were made on two luminous points of different colours, red and blue. The results of some 2000 measures lead to the following conclusions: (*a*) The Purkinje phenomenon only appears to have a sensible effect from stellar magnitude 6. (*b*) The difference between the observed and calculated brightness augments in proportion as the brightness diminishes down to magnitude 11. (*c*) The sense of the phenomenon for luminous points is opposite to that for luminous areas, *i.e.*, if we diminish in the same ratio the brightness of two points of red and blue light the red will become relatively more brilliant. C. P. B.

675. *Rotatory Power and Absorption of Limonene at Low Temperatures.* **F. A. Molby.** (Phys. Rev. 30. pp. 77–91, Jan., 1910.) **F. A. Molby and R. C. Gibbs.** (Ibid. pp. 92–95, Jan., 1910.)—A continuation of low-temperature work on optically active substances [see Abstract No. 444 (1909)], with essentially the same apparatus. The temperature was measured by an iron-constantan thermo-couple with potentiometer, and ranged from 20° to −180°, the solidifying point of the substance. Curves are given of the rotation and specific rotation for various wave-lengths and of the rotary dispersion. Considering the beam of polarised light as composed of two circular constituents, the indices of the substance for the latter do not continue to bear the same ratio to each other as the substance cools. On the other hand, these indices are not increased by the same absolute quantity through cooling. From measurements taken throughout the spectrum the absorptive power is greater for short wave-lengths; also there is a considerable increase in the absorption as the temperature decreases, the rate of increase per degree being much larger at the lower temperatures. G. E. A.

676. *Effect of Pressure on the Elliptic Polarisation of Reflected Light.* **M. Volke.** (Ann. d. Physik, 31. 3. pp. 609–632, March 1, 1910. Extract from Dissertation, Breslau.)—An investigation of the effect of pressure on the change of phase in the region of total reflection. The measurements were made by means of the Lummer-Kynast apparatus [Abstract No. 1162 (1907)], and it was found that pressure in one direction changed the phase-difference by about the same amount for all angles of incidence. The change increases with the pressure, and alters its sign for high refractive indices; this is in agreement with certain measurements made by Pockels. Fresnel's formula represents the experimental results correctly for media which are free from strain. Finally, the efficiencies of the elliptic half-shadow analyser of Zakrzewski and of Lummer's half-shadow polarimeter are determined by numerous experimental measurements. [See also Abstracts Nos. 1617 and 1779 (1908).] G. E. A.

677. *Dispersion in the Electric Spectrum of Kerosine.* **N. N. Obolenskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 7. pp. 265–275, 1909.)—The

author has investigated the electric spectrum of Russian kerosine, consisting of a mixture of naphthenes containing methyl groups, by the method employed by Kolli [Abstract No. 122 (1909)]. The measurements embraced the interval between the values 465 and 281 mm. for the half wave-length in air. It is found that, between the half wave-lengths 385 and 382 mm., there occurs a band which corresponds in position with the band common to the electric spectra of acetone and toluene and regarded by Kolli as typical for the methyl group [Abstract No. 122 (1909)]. For various temperatures rising from 6° to 80° the Mossotti-Clausius constant decreases regularly from 0·8291 to 0·8284, the approximation to constancy being about the same as was found by Tangl for toluene [Abstract No. 1442 (1908)]. T. H. P.

678. *Interference of the Reflected Diffracted and the Diffracted Reflected Rays of a Plane Transparent Grating, and on an Interferometer.* C. Barus and M. Barus. (Science, 31. pp. 894–895, March 11, 1910.)—If parallel light fall obliquely upon a plane transparent grating and the light reflected from a back parallel surface is examined with a telescope, the spectrum is frequently found to be intersected by strong vertical interference bands. If the back reflecting surface is movable, the instrument constitutes an interferometer for which the principal fringes are subject to the equation $\delta e = \lambda/2(\cos\theta' - \cos i)$, where e is the air space, and i and θ' the angles of incidence and diffraction respectively. E. C. C. B.

679. *The Appearance of Curved Lines in the Spark-spectrum of Bismuth.* H. R. v. Traubenberg. (Phys. Zeitschr. 11. pp. 105–106, Feb. 15, 1910.)—Two lines in the spark-spectrum of Bi are found to be curved; that is to say, they are concave towards the red. They have been photographed with a large plane grating, and are reproduced in the paper. It is possible that similarly curved lines are to be found in the spectra of Sb, Te, and Zn. E. C. C. B.

680. *Absorption Spectra of Naphthalene and Tetra-Methyl-Naphthalene.* A. Homer and J. E. Purvis. (Chem. Soc., Journ. 97. pp. 280–284, Feb., 1910.)—In a previous paper the authors concluded that a substance having the empirical formula of $C_{14}H_{16}$ was tetramethylnaphthalene, basing their conclusion upon the absorption spectrum. Since that time two new bands in the absorption spectrum of naphthalene have been noted by Baly and Tuck, and the present authors realised that if their original conclusion were correct the absorption spectrum of the $C_{14}H_{16}$ substance must show two absorption bands analogous to those noted for naphthalene by Baly and Tuck. The absorption of the $C_{14}H_{16}$ substance has been re-examined, and the two new bands were discovered; the evidence in favour of its being tetramethylnaphthalene is therefore exceedingly strong. In their paper Baly and Tuck disagree with Hartley upon the subdivision of the broad absorption band of naphthalene into four; the present authors, in finding this subdivision present, confirm Hartley's original observation. E. C. C. B.

681. *The Spectrum of Bacterial Luminosity.* R. W. Forsyth. (Nature, 83. p. 7, March 3, 1910.)—The spectrum of the light from certain luminous bacteria was photographed with a short-focus instrument, and was found to extend from $\lambda = 5000$ to $\lambda = 3500$ with a well-marked bright band at about $\lambda = 4000$. Further work is being done, but it seems perfectly clear that some ultra-violet light is being emitted. E. C. C. B.

682. *Zeeman-effect on Spectrum Lines of Cadmium and Mercury.* **M. Tenani.** (Accad. Lincei, Atti, 19. pp. 198–201, Feb. 20, 1910.)—The difference between longitudinal and transversal Zeeman-effects, observed with Mg and helium lines [Abstracts Nos. 1539, 1882 (1909)], is found also with the Cd line $\lambda = 4678{\cdot}87$ and Hg line $\lambda = 4046{\cdot}8$. This difference does not follow the law predicted by theory. W. H. St.

683. *Asymmetric Triplets: An Example of Asymmetry Proportional to the Square of the Magnetic Field.* **A. Dufour.** (Comptes Rendus, 150. pp. 614–615, March 7, 1910.)—In a previous paper the author has noted certain lines of Cr which are resolved into several components having as their axis of symmetry not the original line, but a line shifted from the original position by an amount proportional to the square of the magnetic field. [See Abstract No. 1221 (1909).] One of these lines, $\lambda = 5247{\cdot}56$, has now been studied with a Fabry and Perot interferometer, and that the displacement is proportional to the square of the magnetic field has been confirmed. E. C. C. B.

684. *Further Observations on the Unsymmetrical Emission of Röntgen Rays.* **J. Stark.** (Phys. Zeitschr. 11. pp. 107–112, Feb. 15, 1910.)—Some alterations in the form of the tube are first described, then various curves illustrating the results obtained are given. These show that the mean index of absorption for Röntgen rays is a function of the azimuth of the direction of emission, being greater for azimuths $\phi > 90°$, than for azimuths $\phi < 90°$. For azimuths 0° to 90° the mean index of absorption with increasing azimuth appears first to decrease to a minimum and then to increase. For Röntgen rays which are not homogeneous, those rays of smaller index of absorption preponderate, relative to intensity, on the hinder side of the plane normal to the generating bundle of kathode rays (azimuth $\phi < 90°$), while on the front side of that plane, rays of greater index of absorption preponderate. According to the curves, the photographically measured intensity of non-homogeneous Röntgen rays is a function of the azimuth, those rays going to the hinder side of the normal plane being considerably more intense than those going to the front of that plane. When corrections to the curves are made for absorption in the carbon antikathode and in the glass wall, this want of symmetry with respect to photographic intensity is even more marked. A. E. G.

685. *Homogeneous Corpuscular Radiation.* **C. A. Sadler.** (Phil. Mag. 19. pp. 887–856, March, 1910.)—Homogeneous secondary beams were used to investigate in what manner the emission of corpuscular radiation by a substance depended upon the exciting radiation. It was thought probable that when the intensity of the tertiary Röntgen radiation decreased as the secondary beam became more penetrating, an increasing fraction of the energy of the secondary beam absorbed by the tertiary radiator would be expended in corpuscular radiation. The results arrived at are as follows: (1) The corpuscular radiation excited in different metals by homogeneous beams possessing a wide range of penetrating power is absorbed in every case according to an exponential law. (2) The absorbability of the homogeneous corpuscular radiation from a tertiary radiator depends solely upon the degree of hardness of the exciting homogeneous secondary beam, and not at all upon the nature of the tertiary radiator. (3) The absorption coefficient of the corpuscular radiation from any metal, is a linear function of the atomic weight of the metal which acts as the source of the homo-

geneous exciting beam. (4) In the case of those metals which emit a characteristic homogeneous Röntgen radiation when subjected to a suitable exciting beam of Röntgen rays, it is found that whenever the homogeneous Röntgen radiation is produced it is always accompanied by a special increase in the corpuscular type of radiation. Where the homogeneous type of radiation is not produced, there is still a portion of the exciting radiation scattered by the metal, while the intensity of the corpuscular radiation is quite considerable. It is probable that the corpuscular radiation emitted in such cases is intimately connected with this scattering. J. J. S.

REFERENCES.

686. *Urania-Zurich Electrically Controlled Equatorial Telescope.* (Elect. Rev. and West. Electn. 56. pp. 76–77, Jan. 8, 1910.)—Illustrated description.

687. *Flexure of Astro-spectrographs.* **G. Eberhard.** (Zeitschr. Instrumentenk. 30. pp. 29–45, Feb., 1910.)—Discussion of the flexure errors encountered in spectrographs employed for determining stellar radial velocities in the line of sight, and detailed description of a new spectrograph of extremely rigid construction which has been made for the Potsdam Astrophysical Observatory. C. P. B.

688. *Two Stereoscopic Pictures on one Plate.* **E. Estanave.** (Comptes Rendus, 150. pp. 688–685, March 14, 1910.)—When the grating placed in front of the photographic plate has horizontal lines as well as vertical ones, suitable exposure through an objective with four apertures at the corners of a square give the necessary elements from which are obtained two different stereoscopic pictures on the one plate. [See Abstract No. 238 (1910).] G. E. A.

689. *The Sine Condition in Relation to the Coma of Optical Systems.* **S. D. Chalmers.** (Phil. Mag. 19. pp. 856–865, March, 1910. Paper read before the Physical Soc., June 25, 1909.)

690. *Elliptically Polarised Light.* **K. Sorge.** (Ann. d. Physik, 31. 4. pp. 686–714, March 15, 1910. Extract of Dissertation, Breslau.)—Describes a new method of investigating elliptically-polarised light by means of Lummer's "Doppelringe." After a lengthy discussion of the phenomena associated with the "Doppelringe" a description is given of the method and a mathematical theory is developed. The paper does not admit of a brief abstract. A. W.

691. *Wave-length Tables of the Spectra of Tantalum, Zirconium, and Lanthanum.* (Brit. Assoc. Report, pp. 119–209, 1908. Report of B.A. Committee.)

692. *Errors in Wave-lengths of Spectra of Cr, Ca, Ce, and Th Published by Cooper.* **F. L. Cooper.** (Astrophys. Journ. 30. p. 400, Dec., 1909.)—An error in the author's method of calculation affects the results given in Abstracts Nos. 1558, 1559 (1909). No value can be attached to the wave-lengths there given for Ce and Th, nor to those of Ca between λλ2208·82 and 2994·96 and Cr between λλ2132·749 and 8875·257. L. H. W.

693. *Interferential Method applied to Measurement of Small Line-displacements. Comparison of Solar Spectrum with Arc Spectrum of Iron.* **C. Fabry** and **H. Buisson.** (Astrophys. Journ. 31. pp. 97–119, March, 1910.)—Gives in the original French the subject-matter of the work dealt with in Abstracts Nos. 786, 1042, 1402 (1909). L. H. W.

694. *White Light from the Mercury Arc and its Complementary.* **H. E. Ives.** (Bureau of Standards, Bull. 6. pp. 265–271, Nov., 1909. Electrician, 64. pp. 674–675, Feb. 4, 1910. Abstract.)—[See Abstract No. 1068B (1909).]

695. *Temperature-coefficient of the Emission Power of Metals in the Short-wave Region of the Infra-red.* **H. Rubens.** (Phys. Zeitschr. 11. pp. 139–141; Discussion, p. 141, Feb. 15, 1910. Paper read before the 81. Naturforscherversamml., Salzburg. Deutsch. Phys. Gesell., Verh. 12. 4. pp. 172–176, Feb. 28, 1910.)—A measurement of the emission and reflecting power of certain metals for rays lying between $\lambda = 1$ and $\lambda = 8\,\mu$. E. C. C. B.

696. *Determination of some Normals in the Helium Spectrum.* **P. Eversheim.** (Zeitschr. wiss. Phot. 8. pp. 148–150, March, 1910.)—Some measurements of lines in the He spectrum by means of the Fabry and Perot instrument. The mean probable error lies between 0·0008 and 0·0015 tenth-metres, but two of the measurements given are each more than 1 Å.U. larger than the previous values of Rayleigh and of Fabry and Perot. E. C. C. B.

697. *Intensity Relations in the Hydrogen Spectrum.* **P. G. Nutting** and **O. Tugman.** (Astrophys. Journ. 31. pp. 62–75, March, 1910.)—A quantitative study of the variations in the relative intensity of certain hydrogen lines, caused by variations in density and in the intensity of excitation, followed by a theoretical treatment of the problem. E. C. C. B.

698. *Study of the Emission of Gases. I. Measurement of Energy and Intensity in Spectra. II. Spectrum Tubes.* **H. Konen** and **W. Jungjohann.** (Deutsch. Phys. Gesell., Verh. 12. 3. pp. 128–143 and 145–156, Feb. 15, 1910. Phys. Zeitschr. 11. pp. 112–117, Feb. 15, 1910.)—A preliminary paper containing chiefly a discussion of previous work and the difficulties to be found in the investigation. In the second part the best form of vacuum tube for continuous currents is discussed, and the design of the one preferred by the authors is illustrated in the paper. E. C. C. B.

699. *Distribution of Intensity in the Emission of Röntgen Rays.* **A. Sommerfeld.** (Phys. Zeitschr. 10. pp. 969–976, Dec. 15, 1909.)—This is a theoretical paper in which the conclusions of Stark [Abstract No. 250 (1910)] are criticised. The experiments of Kaye on the distribution of Röntgen rays are quoted as in agreement with the theory which is here introduced. The whole is in favour of the electromagnetic theory as opposed to the "light quantity" hypothesis. A. E. G.

HEAT.

700. *Thermal Conductivity.* **A. Badior.** (Ann. d. Physik, 31. 4. pp. 737–757, March 15, 1910. Extract from Inang.-Dissertation, Marburg, 1908.)—A paper dealing with the thermal conductivity of substances artificially rendered anisotropic. The methods of research were similar to those of Sénarmont and Lees. Sénarmont's method was as follows : A plate of the substance had a hole drilled through the centre, through which passed an electrically heated Pt-wire. The plate was smeared with wax and turpentine and pressure applied to two sides of it by means of a parallel vice. The isothermals showed by the melted wax were ellipses, whose minor axes were parallel to the direction of the applied pressure. The experiments made by the author lead to the following conclusions : For glass and slate subject to one-sided pressure no difference of the conductivities parallel and perpendicular to the direction of pressure can, within the limits of accuracy of the experiments (about 1 per cent.), be detected. The results of Sénarmont, showing better conductivity perpendicular to the direction of pressure than parallel thereto, are traced to the disturbing influence of the clamps on the diffusion of heat and on the form of the isothermals. For stretched indiarubber no difference of conductivity in the two directions can be detected. With naturally stratified substances such as schists and some sandstones there is slightly better conductivity in the direction of the lamination than perpendicular thereto. In a laminated body consisting of alternate layers of equal thickness but of different conducting powers, heat travels better along the layers than perpendicular to them. The isothermals in a plane perpendicular to the layers are ellipses with their major axes parallel to the layers. From the ratio of the axes the ratio of the conductivities of the different materials can be calculated. The latter results give a probable explanation of the difference of conductivity in two directions with naturally stratified substances. A. W.

701. *Comparison of the Temperature Measurement according to the Stefan-Boltzmann Law with the Nitrogen Thermometer Scale up to* 1600°. **S. Valentiner.** (Ann. d. Physik, 31. 2. pp. 275–311, Jan. 28, 1910. Communication from the Physikal.-Techn. Reichsanstalt.)—Holborn and Day have compared the e.m.f. of the thermo-element Pt—Pt-Rh with the nitrogen thermometer up to a temperature of 1100° and have obtained a quadratic formula [see Abstract No. 2008 (1900)]. Lummer and Pringsheim found that the values obtained above that temperature for black bodies by extrapolation agreed well with those obtained by radiation measurements [Abstract No. 1208 (1908)]. On comparing the thermo-element with the nitrogen thermometer up to 1600° C. [Abstract No. 437 (1907)] Holborn and Valentiner found that the values of the temperatures previously obtained by extrapolation were too low. In the present paper the author has measured the radiation from various black bodies by means of a Lummer-Kurlbaum bolometer. The bolometer consisted of twenty Pt-strips of about 2 mm. width and 0·001 mm. thickness, which were covered with a layer of platinum-black. Temperatures were measured thermoelectrically and reduced to readings on the nitrogen thermometer. At 100° C. the value of the radiation constant σ is found to be $(1{\cdot}286 \pm 0{\cdot}002) \times 10^{-12}$ gm.-cal./sec., and at the temperature of boiling sulphur

$\sigma = [1{\cdot}26 \pm 0{\cdot}008] \times 10^{-12}$, whereas over the range 828–1438° it has a mean value $1{\cdot}29 \times 10^{-12}$. One of the radiators, composed of magnesia, gave a mean value $\sigma = 1{\cdot}17 \times 10^{-12}$ gm.-cal./sec. over the range 900–1575°; the low value in this case is evidently due to the body not being perfectly black. For the complete discussion of the results obtained the original paper should be consulted. W. C. S. P.

702. *The Definition of the Ideal Gas.* **E. Buckingham.** (Bureau of Standards, Bull. 6. pp. 409–429, Feb., 1910.)—The following three definitions of the ideal gas which are in common use are proved to be in all respects mutually equivalent, each being necessary and sufficient for the others. (1) The ideal gas obeys Boyle's law, and its temperature scale agrees with the thermodynamic scale—that is, $pv = R\theta$. (2) The ideal gas obeys Boyle's law and Joule's law—that is $(pv)_\theta = \text{constant}$, and $(\partial\epsilon/\partial v)_\theta = \theta(\partial p/\partial v)_v - p = 0$. (3) The ideal gas obeys Boyle's law, and its Joule-Kelvin effect is zero—that is $(pv)_\theta = \text{constant}$, and $\rho = \theta(\partial v/\partial\theta)_p - v = 0$. It is also frequently added that the specific heat of the ideal gas at constant volume is independent of the temperature—that is $(\partial C_v/\partial\theta)_v = 0$. The author then discusses the cohesion pressure of a real gas, and proves that $(p + \pi)(v - b) = R\theta$, where R is a constant and π and b are functions of θ and v. He illustrates this equation by the equations of van der Waals and Clausius. A. R.

703. *Saturation Specific Heats, &c., with van der Waals' and Clausius' Characteristics.* **R. E. Baynes.** (Phil. Mag. 19. pp. 407–416, March, 1910. Paper read before the Physical Soc., Jan. 21, 1910.)—The author shows how, by means of a special variable, exact expressions may be found with van der Waals' characteristic for the specific heats, s and s', of saturated liquid and vapour and for all other magnitudes connected with the state of saturation. It is deduced that if k denotes the isometric specific heat, which is constant or a function of the temperature only: (1) $s - k$ is always positive, increasing from R to infinity as the reduced temperature τ rises from 0 to 1; (2) $k - s'$ is always positive, having a minimum value 4·96 R when τ is 0·72, and being infinity when τ is either 0 or 1; (3) inversion in the sign of s' can thus occur when k/R is greater than 4·96, and hence for an N-atomic gas, inversion can occur only if the gas has at least five atoms in its molecule; (4) the latent heat of vaporisation continuously increases as τ falls from 1 to 0; (5) the work of vaporisation has its max. value 0·55 RT when τ is 0·70. It is then shown that Clausius' characteristic similarly treated gives widely different results. For example, inversion in the sign of s' can only occur if there are at least eleven atoms in the molecule. A. R.

704. *Statistical and Thermodynamical Relations of Radiant Energy.* **J Larmor.** (Roy. Soc., Proc. Ser. A. 83. pp. 82–95, Dec. 10, 1909.)—An expansion and generalisation of ideas implied in Planck's analysis of natural radiation. It involves a modification of Boltzmann's application of that method to gas theory, such as is apparently necessary to a direct general view of the molecular significance of temperature. The fundamental thermodynamic principle that thermal energy tends towards the equilibrium distribution, never by any chance spontaneously in the opposite direction, is a direct result of the discrete statistical point of view, and cannot otherwise be justified. The degradation of mechanically available energy is the progress towards its equable molecular distribution, a progress which cannot be undone by any operations on matter which do not rearrange the molecules;

and the measure of the amount of degradation must rest ultimately on statistical principles. The proposition that a molecular system always tends in spontaneous change towards states of greater entropy, runs parallel to the principle that it always tends towards molecular distributions of greater probability subject to the restraints and laws that are inevitable. The entropy is thus in some way a measure of the probability of the molecular collocation. The general thesis concerns the molecular statistics of distributions of energy. A system which is the seat of energy may be apportioned into elementary receptacles of energy to be called "cells." A relation between the extents of these cells is established by the condition that they shall be of equal opportunity—that, in fact, the element of disturbance possessing the element of energy under consideration is as likely in its travels to occupy any one of them as any other. The energy is considered as made up of different elements of amounts $\epsilon_1, \epsilon_2 \ldots \epsilon_r$ for the r possible states of the energy, in which it is distributed among equivalent cells of numbers $N_1, N_2 \ldots N_r$; and the problem is to find $n_1, n_2 \ldots n_r$, which are the numbers of elements of energy that, in the ultimate state of statistical equilibrium, will reside in these groups of cells respectively, subject to the conservation of its total amount E. The author arrives at the formula $n_\epsilon = N\epsilon/(e^\theta - 1)$. This becomes Planck's formula for natural radiation, with θ representing temperature, when the values of N and ϵ are substituted in terms of λ, and when another factor, λ^{-1}, is adjoined to reduce the value to the same unit range of wave-length in all cases. The procedure of Planck for the elucidation of the statistical relations of natural radiation depends essentially on the assumption of a discrete or atomic constitution of energy; and the indivisible element of energy, as estimated from the constants of the formula for natural radiation, proves to be of considerable amount, even compared with the energy of a molecule of a gas. A somewhat similar implication survives in the present development, but it now appears in the form that the ratio of the energy element to the extent of the standard cell is an absolute physical quantity. E. E. F.

705. *Noble Gases and the Equation of State.* II. **G. Rudorf.** (Ann. d. Physik, 81. 2. pp. 416–422, Jan. 28, 1910.)—The author modifies his criticism [Abstract No. 1568 (1909)] of Happel's proof of the equation, $\lambda = RT + a/v_1$, for argon, where λ is the latent heat of evaporation at the absolute temperature T and v_1 the specific volume of the liquid at the temperature T [Abstract No. 282 (1907)]. He shows, however, that agreement between the observed and calculated values of v_1 does not exist at temperatures other than 85°, and that a small inaccuracy in the value of λ exerts a considerable influence on the calculated value of v_1. Comparison of the values of v_1 for argon, krypton, and xenon with the value for RaEm, on the assumption that the molecular weight of the latter is 176 [compare Ramsay and Gray, Abstract No. 1684 (1909)], indicates that the more probable value for the molecular weight of RaEm is 223; a similar indication is given by comparing the values of λ for these various gases. T. H. P.

REFERENCE.

706. *Apparatus for Measuring Vapour Pressure of Dilute Aqueous Solutions.* **R. Maier.** (Ann. d. Physik, 81. 2. pp. 423–435, Jan. 28, 1910. Extract of Dissertation, Tübingen.)—Illustrated description.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

707. *Theory of Motion of Charged Ions through a Gas.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 15. No. 4. pp. 375–380, Jan. 31, 1910.)—In the usual method of calculating the velocity of a charged ion through a gas, the expression $X e \lambda / m u$ for the velocity is obtained on the assumption that the ion after each encounter with a molecule of the gas starts afresh, and is as likely to move in any one direction as the opposite. The momentum communicated to the ion by the electric field in the interval before a collision, is assumed to be transferred to the molecule of the gas during that collision, from which it follows that the max. velocity communicated to an ion by the electric field is that imparted to it in the short interval between two collisions. It seems clear, however, that the time during which the velocity is acquired by the ion is the average time during which the ion continues to move in one direction and not the time between two collisions, and the time taken for an ion to have its motion reversed by its collision with the other molecules may be much greater than the time between two collisions. This will certainly be the case if the mass of the ion is considerably greater than that of the molecules against which it strikes. The mathematical theory is then worked out on this view and the mobility of an ion, *i.e.*, the speed with which it moves through the gas under unit electric force, is worked out. It is shown that the velocity, through hydrogen, of an ion made of a molecule of hydrogen charged with electricity would be about half as much again as that of a charged molecule of methyl iodide through hydrogen, and so would easily be distinguished from it. E. H. B.

708. *Initial Motion of Electrified Systems and Radiation Reaction.* **G. W. Walker.** (Roy. Soc., Phil. Trans. 210. pp. 145–197, March 2, 1910.)—Whereas most investigations of high-speed motion of charged bodies suppose them to be very small, the present paper considers charged systems of finite extent; and, in examining the acceleration of such systems, allows for the reaction produced by the resulting radiation. The calculations thus made indicate the way in which the process of attempting to establish a uniform acceleration, at speeds nearly that of radiation, may fail. The damped harmonic train of waves may have such a small damping coefficient that it is no longer legitimate to neglect those waves, and a uniform acceleration cannot, in point of fact, be established. An uncharged sphere of atomic size would, under ordinary conditions, give fundamental vibrations of frequency corresponding to extreme ultra-violet radiation, damped with exceeding great rapidity. But it is here shown that, at a speed approaching that of radiation, the fundamental vibration may be brought within the visible spectrum-range, and at the same time the damping becomes relatively small. E. H. B.

709. *Electrification of Insulating Materials.* **W. Jamieson.** (Nature, 83. p. 189, April 14, 1910.)—Strong electrification was found to be produced on stroking a bundle of strips of celluloid. If two narrow strips of celluloid were rapidly pulled between the fingers they both became electrified, one of

the surfaces in contact being positive and the other negative. One of these surfaces is in compression and the other in tension; with celluloid the compressed surface is always negatively, the stretched surface positively, electrified. Similar effects were observed with paper, vulcanite, and shellac, and in a less degree with mica. J. J. S.

DISCHARGE AND OSCILLATIONS.

710. *Absorption of Ions by Falling Water-drops.* **R. Seeliger.** (Ann. d. Physik, 31. 8. pp. 500–518, March 1, 1910.)—A repetition of some work by Schmauss [see Abstract No. 460 (1908)], whose results the author has not been able to corroborate. It is attempted to measure by an electrometer the negative charge brought down by a stream of drops of water falling through air ionised by Röntgen rays. Great care is taken to eliminate as far as possible errors arising from (1) the "water-dropper" effect, as the drops leave the nozzle; (2) the Lenard-effect, as the drops hit the receptacle; (3) the charging or discharging of the receptacle from other causes. The results are: (1) Water-drops falling through ionised air take up a small negative charge, but this is only of a measurable quantity, if the Röntgen rays are kept ionising the air as the drops are falling. If the Röntgen rays are stopped before the drops are let fall, there is no trace of a negative charge. (2) It is probable that the air film around each falling drop is much more strongly ionised, owing to secondary radiation from the drop, than the rest of the air. (3) The effects observed by Schmauss are about a thousand times too great. T. P. B.

711. *Ionisation produced by Entladungsstrahlen, and Experiments on Nature of Radiation.* **E. R. Laird.** (Phys. Rev. 30. pp. 293–310, March, 1910.)—This paper describes a series of experiments upon the action of the radiation from the spark of a Wimshurst machine or induction coil. By the thermo-luminescent effect it is shown that the radiation comes from the whole length of the spark and cannot be due to metallic dust driven from the electrodes; nor is this effect due to direct electrical induction. The only solid substance which appears to be transparent to the effect is thin celluloid in the form of films made by letting fall a drop of a solution of celluloid in amyl-acetate on water. The ionisation in the air or gas in the chamber into which the radiation enters is not an effect of the metal electrode, or the walls of the chamber, neither is it produced by diffusion into the chamber of ions from the outside, but is entirely due to the contained air or gas. The relative effects obtained with air, coal-gas, CO_2, turpentine, ether, ammonia, alcohol, methyl iodide, and H_2O, are given, and these vary greatly with the different vapours. Experiments on the reflection of the radiation are also described. That this radiation does not appear to be of the nature of α- or β-rays or neutral pairs shot off from the spark is maintained, since it passes through 10 cm. of air, and yet is stopped by very thin Al. It is also evidently not light of wave-length greater than 1000 Å.U., since in the known regions quartz is everywhere comparable in transparency with air. The fact that the results are independent of the nature of the electrode materials is a reason for thinking the effect more electrical in its origin, in the sense of being independent of the particular atom. A. E. G.

712. *Rays of Positive Electricity.* **J. J. Thomson.** (Phil. Mag. 19. pp. 424–435, March, 1910.)—In previous experiments [see Abstracts Nos. 1669 (1907),

128 (1910)] the streams of positive electricity were produced by means of an induction coil. When discharges are produced in this way the p.d. between the terminals varies considerably during the discharge, and the method is not suitable for those experiments in which accurate measurements of the p.d. during the discharge are essential. A Wehrsen (Mercedes) electrostatic induction machine is therefore employed, and by this means observations on the canal rays are made with p.d.'s varying from 40,000 to 8000 volts. Experiments are described which show that the velocity of the particles is the same when the pressure is very low, and the p.d. between the electrodes 40,000 volts, as when the pressure is higher and the p.d. only 8,000 volts. It thus appears that when the pressure is high the velocity of some of the positively charged particles is greater than that which could be imparted by the electric field, as the particles move from the place where they are liberated up to the kathode. The place where the positively charged particles are produced can, by observation of the shadows thrown by obstacles placed in front of the hole in the kathode, be shown to be the region near the boundary of the dark space; thus if the particles when liberated were positively charged, the velocity they would acquire from the electric field would be that due to a fall through the dark space; hence if this were the source of their velocity, a passage back through the dark space from the kathode to the anode would bring them to rest at the boundary of the dark space, and they would not travel any further down the tube. Experiments are described to test this point, and as a result of these it is concluded that the great speed of the canal rays is not due to the direct attraction of the kathode on their positive charges. It is again suggested, as in a previous paper [Abstract No. 128 (1910)], that the velocity of the positive particles when they have travelled some distance from the kathode is determined by the properties of a system of dissociating neutral doublets; such doublets appear to compose the canal rays, or at least those which are deflected by electric or magnetic forces. It is also found that the "retrograde rays" have the same velocity as the canal rays over wide variations of p.d. In the case of these rays it would appear that the electric field produces some kind of polarisation in the molecules which makes them eject the uncharged doublets along the line of motion of the kathode rays in their neighbourhood. While there is no question that the canal rays originate in the region near the outer boundary of the dark space, the place of origin of the retrograde rays is more difficult to fix. Experiments seem to indicate that some of the retrograde rays start from the positively electrified first layer, and not from the metal of the kathode. A. E. G.

713. *Absorption of Kathode Rays in Gases.* **H. Baerwald.** (Deutsch. Phys. Gesell., Verh. 12. 4. pp. 159–171, Feb. 28, 1910. Phys. Zeitschr. 11. pp. 145–158, March 1, 1910.)—Lenard was the first to carry out measurements on the absorption of kathode rays by bodies of densities varying from that of hydrogen to that of gold; the method he employed was an optical one based upon the use of phosphorescent screens. More recently Becker [Abstract No. 847 (1906)] has repeated the measurements, making use of an electrometer for this purpose. The results of these observers are in accord when the absorption coefficients are taken with air as unity, but the absolute values of the coefficients obtained are in the ratio 1 : 2 about. In the present paper, which is of a preliminary nature, results are given for air, hydrogen, nitrogen, oxygen, N_2O, CO, CO_2, and SO_2, which, with the exception of those for SO_2, are in good agreement with those obtained by Becker. The latter,

however, calculated his dielectric constant by the Boltzmann electric method, while those made use of in the present paper are obtained from the index of refraction for sodium light by the Maxwell-Boltzmann law. A. E. G.

714. *Nature of Magneto-kathodic Rays.* **H. Thirkill.** (Roy. Soc., Proc. Ser. A. 88. pp. 324–334, March 2, 1910.)—The failure to detect a charge on the magneto-kathodic rays, and the necessity of a magnetic field for their production, have led Villard and Righi to regard them as a new kind of rays. Righi has recently put forward the hypothesis that these rays consist of neutral doublets: a negative corpuscle revolving round a positive ion. This would explain their lack of charge, their behaviour in a magnetic field, and some other properties of the rays. Experiments are now described which seem to show that these rays consist of slowly moving negatively charged particles. Under the influence of the powerful magnetic field, these have been coiled up to form a very fine spiral along the lines of magnetic force passing through the kathode. The discontinuity of the phenomena observed in many of Righi's experiments is also explained by the above assumption as to the nature of these rays. The rays are shown to carry a negative charge. A Faraday cylinder is used for this purpose, the measuring instrument being a sensitive galvanometer. A. E. G.

715. *Heat Liberated at Antikathode of Röntgen Tubes.* **A. J. de Beaujeu.** (Journ. de Physique, 9. pp. 281–286, March, 1910.)—Wien measured the energy of the kathode rays by the elevation in temperature of a known mass of water contained in a reservoir of which the antikathode formed the base, the rise in temperature being measured by a thermometer placed in the water. He determined the energy corresponding to this elevation of temperature by placing in the water a coil of wire through which a known current passed. E. Carter used a tube with cooled antikathode, and, following Wien's method, found that the energy of the kathode rays is 4·8 gm.-cals. per sec. [Abstract No. 291 (1907)]. The method now adopted is similar to that of Wien and Carter, and the results obtained are in accord with those of Carter. It is found that if W_1 represents the power of the primary in watts and Q the quantity of heat liberated per sec. in gm.-cals., then W_1/Q = a constant = 67, for watts ranging from 228 to 440. It is suggested that it would be of interest to ascertain what fraction of the energy W_2 of the secondary is transformed into heat, and it is thought that W_2/Q ought to be about 4·17, since the energy of the Röntgen rays is very feeble. A. E. G.

716. *Form of Wave through a Crookes Tube when excited by Condenser Discharge with Large Self-inductance.* **A. Broca** and **Delon.** (Archives d'Él. Médicale, 18. pp. 886–887, April 10, 1910.)—An apparatus by which the potential obtained from a transformer is doubled, by means of a turning contact and a condenser, is constructed for the production of intense Röntgen rays. When the tube is put in series, the curve of the discharge presents a series of regular waves of large amplitude, but always of the same sign. These oscillations have a period of 1/2800 sec. for a tube requiring an equivalent spark of 10 cm. and delivering a current of 5 to 6 milliamps. The period is independent of the capacity of the condenser and also of the self-inductance of the transformer within very large limits. A. E. G.

717. *Effect of Capacity of Electrodes on the Discharge.* **E. Caudrelier.** (Comptes Rendus, 150. pp. 615–616, March 7, 1910.)—The author has

previously shown that the striations in the spark of an induction coil are due not only to the capacity of the primary circuit, but also to that of the electrodes of the secondary circuit [see Abstract No. 266 (1910)]. Using a small Rowland transformer having the windings so arranged that the electrostatic capacity is a minimum, and using points for electrodes he finds that there are no striations in the spark. If the spark-gap be shunted with a very small condenser striations immediately appear. The essential cause of this phenomenon is therefore the capacity of the arrangement. A. R.

718. *Potential Gradient in the Immediate Neighbourhood of the Kathode in a Luminous Discharge.* **W. H. Westphal.** (Deutsch. Phys. Gesell., Verh. 12. 6. pp. 275–290, March 30, 1910.)—The potential gradients at points ranging from 0·5 to 2·5 mm. from the kathode are measured, and that at the kathode ("Potentialsprung") is then obtained by extrapolation. A new null method of measuring the potential in the kathode rays is described. It is shown that a sound placed in the Crookes dark space is charged up at equal rates by negative and positive ions. The potential gradient at the surface of the kathode is, for any particular combination of gas and electrode metal, independent of the pressure and the current when the kathode-fall is normal. It is found to have a characteristic constant value which is in a certain manner related to the normal kathode-fall. With an increasing abnormal kathode-fall this "Potentialsprung" also increases, but no connection between this and the kathode-fall is found. Further quantitative measures are in progress. A. E. G.

719. *Electric Discharges through Hydrogen.* **J. Trowbridge.** (Amer. Journ. Sci. 29. pp. 341–349, April, 1910.)—Certain hydrodynamic analogies presented by the discharges of electricity through gases are discussed. The hydrodynamical analogies are more striking in discharges through gases at comparatively high pressures, while molecular theories apply best in highly rarefied gases. As the result of his experiments with various forms of discharge tube the author arrives at the following conclusions: (1) The striæ in Geissler tubes are analogous to waves set up in narrow channels by opposite pulsations of different periods. (2) Striæ are greatly influenced by the direction of kathode rays. Certain forms of tubes can imitate the action of a transverse magnetic field in apparently increasing the conductibility of rarefied gas and restoring the condition of stratification. (3) Striæ can be formed by condenser discharges; and such striæ lead to the supposition of a time of ionisation beyond our power of measurement. By means of a suitably placed diaphragm successive stages in stratification can be produced. (4) By modification of the form of discharge tubes rectification of alternating discharges is possible. (5) The Doppler-effect in hydrogen is not modified by causing two sets of canal rays to oppose each other. J. J. S.

720. *Diffraction of Electromagnetic Waves by a Dielectric Cylinder.* **C. Schaefer** and **F. Grossmann.** (Ann. d. Physik, 31. 3. pp. 455–499, March 1, 1910.)—An amplification of an earlier piece of work [see Abstract No. 882 (1909)]. Two-thirds of the paper is mathematical and cannot be abstracted. In addition to what is mentioned in the above Abstract, it is shown that, to the side of the dielectric cylinder, at right angles to the direction of propagation of the waves, there are interference bands, just as in front of the cylinder, but the distance between two maxima in the latter case is $\lambda/2$, whereas in the former case it is λ (λ = wave-length). The peculiar distribu-

tion of energy round the surface of cylinders of different diameters is shown in curves. Curves also show the connection between the energy at a point 10 cm. behind the cylinder axis and the radii of cylinders. The form of these curves is shown to be connected with electric oscillations in the dielectric cylinder. The case in which the electric field is perpendicular to the cylinder axis is also considered. The theory is tested by the use of short electric waves from a Hertz oscillator. A thermo-couple is used as detector; the dielectric cylinder is water in thin-walled glass tubes. The experimental results confirm theory in nearly every particular. The authors claim that this is the first time that an electric oscillation in a dielectric has been demonstrated. T. P. B.

721. *Measurement of High-frequency Resistance of Wires.* **J. A. Fleming.** (Electrician, 64. pp. 716–717, Feb. 11, 1910.)—Using the apparatus described in Abstract No. 259B (1910), the author has re-measured the high-frequency resistance (R′) of certain standard sizes of straight copper wires. The resistances are for damped oscillations, but the correcting factor is only about 1·007, so that the difference is negligible (< 1 per cent.); the correction for the condenser charging current passed through the wire is less than 0·25 per cent. The value adopted for e (the resistivity) in the Russell formula is 1700. The Table is reproduced in part.

Conductor Tested.	Frequency n.	Measured Ratio of Resistances R'/R.	Calculated Value of R'/R for Undamped Oscillations of Frequency n.	Remarks.
Bare No. 14 S.W.G. copper wire.....	585,000	5·85	5·92	Ratio R'/R calculated by first three terms of Russell formula.
Diameter, d=0·203 cm.	900,000	7·59	7·60	
Bare No. 16 S.W.G. copper wire.....	475,000	4·57	4·53	
d=0·1626 cm.	485,000	4·57	4·56	
Bare No. 36 S.W.G. copper wire.....	510,000	1·01	1·02	Calculated by interpolation from Kelvin *Ber, Bei* formula.
d=0·0193 cm.	880,000	1·06	1·07	
Bare No. 40 S.W.G. copper wire.....	880,000	0·98	1·005	
d=0·012 cm.	—	—	—	

L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

722. *Sensibility of the Barretter.* **B. Gáti.** (Phys. Zeitschr. 10. pp. 897–899, Nov. 22, 1909.)—The author has now been able to produce barretters having a wire diam. of 0·5 μ (0·0005 mm.), the difficulty of production being so great, however, that only about 1 to 2 per cent. of those made are usable. A calibration curve of one of these barretters is reproduced, showing that with a galvanometer of sensibility 1×10^{-7} amp. a deflection of 50 divs. is obtained for 31 microamps. (5 divs. for 1 microamp. high-frequency current). With a pivot galvanometer of sensibility 1×10^{-6} amp., 10 divs. are obtained for 85 microamps. These barretters burn out if 8 milliamps. are passed through them; the optimum bridge current is 2·5 milliamps., as compared with 18 milliamps. for the 2-μ barretter. The resistance is 350 ohms.

L. H. W.

723. *Electric Wave Receivers.* **H. W. Webb** and **L. E. Woodman.** (Phys. Rev. 30. pp. 192–198, Feb., 1910.)—The Klemenčič receiver has been considered in an earlier paper [see Abstract No. 1924 (1909)]. It was shown there that the use of a fine platinum-constantan couple gave greatly increased sensitiveness. In the present paper the "radiometer" receiver, devised by Hull, is considered; an entirely new form, however, is used. The resonator itself is the suspended system in the radiometer, and the vane at one side is heated directly by the induced currents passing through it. The vane is of Au or Pt-foil, the latter being by far the more sensitive. A mica vane behind the foil cuts off the gas action on the one side. The arrangement is made symmetrical, so that it is indifferent to ordinary heat radiation. For very short waves the vane itself is the resonator. The pressure of the gas for max. sensitiveness is 0·04 to 0·07 mm. The zero reading is very steady. When everything is taken into consideration, this receiver is ten times more sensitive than the best Klemenčič; it is self-contained, but on the other hand, the resonating length cannot be easily altered. Mechanical receivers depending on electrostatic and electrodynamic forces are then considered, and it is shown that when energy sufficient to give several thousand division deflections with a Klemenčič was incident upon a very delicate electrostatic receiver, there was no visible deflection. From theory it is shown that the sensitiveness of a mechanical receiver falls off far more rapidly as the wavelength is diminished than does that of "temperature" receivers. T. P. B.

724. *The Bifilar Electrometer and its Applications.* **P. T. Wulf.** (Annal. Soc. Sci. de Bruxelles, 34. 1. Mem. pp. 1–87, 1910.)—In this prize memoir a full account is given of the author's electrometer and its uses [see Abstracts Nos. 1087, 1910 (1907) and 1104 (1909)]. In its simplest form it consists of two fine Pt-coated quartz threads which hang side by side from an insulating support and are kept in tension by a piece of tin-foil fixed to their lower ends. On receiving a charge the threads move apart in the centre and the displacement is measured with a microscope. To render the instrument suitable for transport, the tin-foil is removed and the threads are attached at their lower extremities to a thread of quartz bent in the form of a semicircle. In order that the instrument may indicate sign as well as magnitude of charge, the threads are surrounded with a charged auxiliary conductor. The theory of the instrument is examined, and the relation between potential and displacement of the threads is shown to be nearly linear. The capacity is measured experimentally (0·4 cm. for the moving parts), and the variation of capacity with movement of the threads is shown to be very slight. The form of the calibration curve is shown to be independent of the potential of the auxiliary conductor. Examples are given illustrating the applications of the instrument to measurements in radio-activity and in atmospheric electricity, and auxiliary apparatus for these purposes is described including a photographic recorder. The memoir concludes with a description of the use of the instrument as an oscillograph. H. W. M.

725. *A Theoretical and Experimental Study of the Vibration Galvanometer.* **F. Wenner.** (Bureau of Standards, Bull. 6. pp. 347–378, Feb., 1910.)—The importance of the e.m.f. developed by the relative motion of the magnet and the winding of the galvanometer is pointed out and the general theory of the instrument is developed. The fundamental equation is stated and a solution is obtained giving the various working constants in terms of the intrinsic constants. The advantage of using a transformer with an instrument de-

veloping a relatively large back e.m.f. is shown. The double period sometimes observed is due to the system being unsymmetrical. A method of tuning more sensitive than the method generally employed is described. It consists in adjusting the frequency of the driving force or the moving system so that the phase-angle between the driving force and the displacement produced is 90°. Equations are found giving the intrinsic constants in terms of the resistance, the direct-current sensibility, the current sensibility, the e.m.f. sensibility, and the resonating frequency, all of which can be accurately measured. Intrinsic and working constants for three instruments are given, some of which were determined by two independent methods and thus serve as checks on the theory. In designing a high-sensibility instrument for bridge work the following rules should be observed: On account of the back e.m.f. the resistance of the galvanometer should be very much smaller than the resistance of the bridge. The back e.m.f. should be one-half of the impressed e.m.f. The mechanical power necessary to maintain a vibration of unit amplitude at the desired frequency should be as small as possible.

A. R.

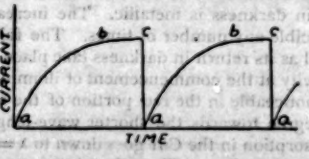
726. *Change of Conductivity of Solid Copper Iodide in Light.* **G. Rudert.** (Ann. d. Physik, 31. 8. pp. 559–596, March 1, 1910. Extract from Dissertation, Jena, 1909.)—Thin layers of copper iodide were prepared by the action of iodine vapour on a kathodic deposit of copper on a glass plate. The CuI layers were transparent, and 100 to 800 $\mu\mu$ thick. The chief observations are summed up by the author as follows: Copper iodide experiences, when exposed to light, an increase in electrical conductivity. Its conductivity both in light and in darkness is metallic. The increase on illumination is apparently reproducible any number of times. The falling-off of the resistance in light as well as its return in darkness take place gradually. A sudden change of conductivity at the commencement of illumination is not observed. The action, whilst noticeable in the red portion of the spectrum, increases in an extraordinary degree towards the shorter wave-lengths, especially in the blue. The light-absorption in the CuI goes down to $\lambda = 880\ \mu\mu$ (as far as was observed) parallel to the effect. The effect is proportional to the intensity with very short times of illumination, but no longer increases in an equal degree with longer illumination. The absolute as well as the relative decrease of resistance on exposure to light, is greater the greater the resistance of the preparation in the dark. With preparations poor in iodine the following dependence of the effect on temperature is shown: The action which is produced by constant short illuminations increases with rise of temperature. On the other hand, the changes in conductivity due to prolonged illumination are greater the lower the temperature is. The author suggests the following explanation of the phenomena: The light causes in the CuI an electric neutral dissociation process, by which free iodine is formed. This follows the laws which hold for photochemical reactions, and especially is proportional to the duration of the illumination, and to the intensity of the light. The appearance of the dissociation products of the CuI formed in the light produces a further reaction which unites the same again to CuI, and so after longer illumination a stationary state is brought on. The counter reaction has the temperature-coefficients of ordinary chemical reactions, and is not influenced by light.

J. J. S.

727. *Conduction of Electricity through Solid Silver Chloride.* **M. Le Blanc and F. Kerschbaum.** (Zeitschr. Elektrochem. 16. pp. 242–244, April 1, 1910.)—The authors communicate a number of peculiar phenomena observed

in the case of electrical conduction through solid silver chloride. It was found that when a voltage of 10 volts was applied to the electrodes at room temperature, containing a cylinder of silver chloride between them of about 49 mm.^{3} × 8–4 mm., a current of about 2×10^{-7} amp. was obtained, showing a resistance for the silver chloride of many million ohms. After some time (hours), however, the current began to increase at an ever-increasing rate, until by the fifth day the current was 53 milliamps., while the electrode potential had fallen to 2·1 volts. The resistance therefore had fallen to about 40 ohms. By starting with a higher voltage this increased conductivity could be reached sooner. A reversal of the current did not alter things essentially. A determination of the resistance of the cylinder by alternating current gave values similar to those calculated from electrode potential and current strength. No metallic silver could be detected even after 6 amp.-hours had flowed through the silver chloride. The authors consider that they are here dealing with electronic conduction. A. F.

728. *The Wehnelt Interrupter.* **K. T. Compton.** (Phys. Rev. 30. pp. 161–179, Feb., 1910.)—A systematic experimental study of the interrupter is made with anode points of different size. With gradually increasing current the action of the interrupter can be divided into three stages—the electrolytic, the interruption, and the fatigue stages. The lower and upper limits of the interruption stage and causes which affect these, and the frequency of the interruptions, viz., strength of solution, temperature, capacity, and inductance, are studied, and, after stating various explanations of the phenomenon



which have been suggested, the following theory of the process is put forward: The electrolyte immediately surrounding the wire anode is vaporised by the heat developed, not in overcoming the ohmic resistance of the Pt, but in overcoming the transition resistance between the wire and the liquid, and the resistance of the electrolyte very close to the point. As this greatly increased resistance increases the amount of heat evolved for the instant, a portion of the vapour is dissociated into oxygen and hydrogen, and thus an insulating sheath of an explosive mixture is formed round the point, stopping the current. The arrangement then acts as a charged condenser with small capacity and high p.d. The latter breaks down the gaseous dielectric, exploding the mixture, and permitting the liquid again to make contact. With regard to the current-time curve shown, the following observations are made: The higher the temperature of the electrolyte, the shorter is the part *bc* of the curve. The greater the self-induction, the longer and less erect is the part *ab*. The larger the anode point, the larger are the dimensions of the whole figure. With excessive currents the break may occur before *b* is reached, the figures become irregular, and some sections may be skipped. The higher the conductivity of the solution, the larger is the whole figure, and *ab* becomes more erect. The greater the specific heat of the solution, the longer is *bc*; and the greater the self-induction in the circuit, the more regular are the interruptions. G. E. A.

729. *Resistance of Certain Electrolytes in a Magnetic Field.* **W. W. Stifler.** (Phys. Rev. 28. pp. 382–385, May, 1909. Abstract of paper read before the Amer. Physical Soc., Nov. 28, 1908.)—The author's experiments show that an abrupt change in resistance takes place when the magnetic field is thrown on. The electrolytes used were cobaltous chloride, ferric chloride, and copper sulphate. The field strength was 20,000 c.g.s. units. The average decrease in resistance when the field is on is about 0·28 per cent. in the case of cobaltous chloride, and 0·26 per cent. for ferric chloride. This change of resistance is independent of the direction of the field, and of the direction of the bridge current through the electrolyte. In the case of copper sulphate the change of resistance is independent of the field direction, but is reversed if the bridge current is reversed. L. H. W.

730. *Influence of Pressure on the E.M.F. of Standard Cells.* **E. Cohen** and **L. R. Sinnige.** (Zeitschr. Phys. Chem. 67. 5. pp. 513–537, Sept. 24, 1909.)—The results of such experiments as are described in a former paper [see Abstract No. 574 (1909), and ibid. 67. 1. pp. 1–47, July 6, 1909] render it possible to determine the influence of pressure on the e.m.f. of standard cells. In the experiments described in the present paper, Weston and Clark cells are subjected to pressures of 1, 250, 500, 750, and 1000 atmos. In the case of the Weston cell the mean value of dE/dP is $0·632 \times 10^{-6}$ volt per atmo., and for the Clark cell dE/dP is $1·28 \times 10^{-6}$ volt per atmo. The general results are as follows:—

Weston Cell. Temp. = 25°. Pressure in Atmos. (P).	E.M.F. Volts.	dE/dP.	Clark Cell. Temp. = 25°. Pressure in Atmos. (P).	E.M.F. Volts.	dE/dP.
1	1·01827	$0·656 \times 10^{-6}$	1	1·41999	$1·30 \times 10^{-6}$
250	1·01991	0·636 ,,	250	1·42325	1·24 ,,
500	1·02150	0·608 ,,	500	1·42634	1·20 ,,
750	1·02302	0·628 ,,	750	1·42933	1·17 ,,
1000	1·02459	—	1000	1·43226	—

F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

731. *Mechanical Measurement of Hysteresis in a Rotating Field.* **G. Vallauri.** (Atti dell' Assoc. Elettr. Ital. 13. pp. 437–456, Sept.–Oct., 1909. Elettricità, Milan, 34. pp. 126–127, Feb. 24, and pp. 141–143, March 3, 1910.)—The author divides previous investigations into two classes: (1) Those which differentiate between rotating and alternating hysteresis, and (2) those which make no particular difference between the two. Examination of the methods employed under class (2) leads him to the conclusion that the fields actually employed in these cases were practically alternating in character; whilst all authors who have made use of the mechanical method belong to class (1). In the present research the author employs a form of Ewing hysteresis-tester, in which the mechanical torque exerted on the specimen is measured by weighing. The magnetic induction is measured ballistically, and ranges between 1300 and 20,000 gauss. The eddy currents are arrived at by calculation, and the friction losses separated from the total losses by a special method described. The hysteresis losses are then obtainable from

the equation $w_r = 2\pi gC/V = 89{\cdot}8\,C$, where C is the torque in cm.-kg., V the volume of the iron, and w_r the rotating hysteresis loss in ergs per cm.^{3} per cycle. The alternating hysteresis (w_a) was determined ballistically for comparison, and curves are given showing the hysteresis loss for various inductions; and for a rotating field also. These show that the ratio w_r/w_a has its maximum (= about 2) at values of B below 4000, and falls off to unity at B = 17,800. A similar behaviour is shown by the phase angle ϕ from the equation $w_r = \frac{1}{2}HB\sin\phi$, if ϕ be plotted as a function of B. From the angle ϕ the angle of lag of the magnetic axis of the armature can be determined; this reaches a maximum of 7° at B = 4000, and falls to 0·9° above B = 9000. The measurements are considered to indicate that rotating hysteresis varies with the magnetisation according to a law which is entirely different from that of linear alternating hysteresis. The rotating hysteresis reaches a maximum of 10,400 ergs at B = 16,000, and falls off to 6800 ergs at B = 20,000. L. H. W.

732. *Variations in the Magnetic Properties of Iron with Temperature.* **C. Maurain.** (Comptes Rendus, 150. pp. 777–780, March 21, 1910.)—The tests have been carried out only for low fields, an alternating field of intensity decreasing gradually towards zero being always superposed to reduce the hysteresis to a minimum. Three rings, A, B, and C, have been tested containing 0·045, 0·18, and 0·87 per cent. carbon respectively. For low fields (*e.g.*, H = 0·09) the permeability of A rose to a maximum at about 200° C., fell to a minimum at 550°, attained a second maximum at 680°, and then diminished as the critical temperature was approached. The minimum at 550° seems to be due to a modification of the iron itself, as it does not occur with B and C. These latter show enhanced permeability at about 225° and 155° C. respectively. This behaviour is considered by the author to be connected with variation in the magnetic properties of cementite, the critical temperature of which has been shown by Wologdine to be about 180°. A. D. R.

733. *Magnetic and Electrical Properties of Iron-Silicon Alloys.* **C. F. Burgess** and **J. Aston.** (Metallurgical and Chem. Engin. 8. pp. 181–188, March, 1910.)—The paper describes a continuation on the same lines of the authors' previous researches on iron alloys [see Abstracts Nos. 446 and 616 (1910)]. Silicon-iron alloys were shown by Barrett, Brown, and Hadfield to be of considerably greater permeability than ordinary iron. The present tests do not show a general improvement of permeability due to the presence of Si in electrolytic iron, but the experience of practice is confirmed in that a high-Si alloy, after annealing at high temperature, is of high permeability for very low magnetising forces and densities such as are used in transformer design. The improvement found here is not so great as in commercial materials, and hence it may be that the effect of the Si is more pronounced in the presence of certain impurities or after special heat treatment. The Si alloys have high electrical resistance, which renders them suitable for transformer working. A. D. R.

734. *Magnetic Properties of Electrolytic Iron and Commercial Steels.* **C. F. Burgess** and **J. Aston.** (Metallurgical and Chem. Engin. 8. pp. 191–194, April, 1910.)—Data are given of tests made upon various samples of electrolytic iron, together with those upon the original anode material, thus exhibiting the effect of refinement upon the magnetic quality. Tests are also described on certain commercial steels representing varying degrees of

purity. In general, the material of higher purity is of higher magnetic quality, and the refining of commercial steels results in improvement in the magnetic properties. The amounts of impurities met with in commercial practice do not, however, cause serious deterioration of the quality. Judicious heat and mechanical treatment has an importance equal to that of chemical composition, and proper annealing undoubtedly results in marked improvement in the magnetic quality. A. D. R.

735. *Magnetisation at very Low Temperatures.* **P. Weiss** and **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 649–677, March 24, 1910. Communication No. 114 from the Physical Laborat., Leiden. Also Comptes Rendus, 150. pp. 686–687, and pp. 687–689, March 14, 1910.)—Starting from Langevin's electronic theory of magnetism, supplemented by Weiss's idea of a molecular field [Abstracts Nos. 1449 (1905), 1980 (1907)], it is taken that the sum of the molecular magnetic moments is only to be obtained from the magnetisation at absolute zero, as it is only then that heat motion can no longer prevent the magnetisation from attaining its full value. To test the theory comparative measurements of the saturation intensity were made by the method of the maximum couple exerted by an intense magnetic field on an ellipsoidal specimen. Short ellipsoids of Fe, Ni, Co, magnetite, V, Cr, and Mn were tested at ordinary temperature and at the temperature of liquid hydrogen (20° abs.), in fields up to 24,200 gauss. The ratio of the intensity of magnetisation at 20° abs. to that at ordinary temperature was found to be: Ni, 1·0548; Fe, 1·0210; magnetite, 1·0569. It is considered that in ferromagnetic substances the magnetic atom does not itself change much with temperature. In experimenting with pure Mn it was found that this metal can exist in two states, paramagnetic and ferromagnetic, and a hysteresis curve is given for a rod of the ferromagnetic manganese. There is an absence of strong magnetism in V, Cr, and Mn at low temperatures. Details of the method, apparatus, and measurements are given in the first-mentioned paper. [*Errata*, Konink. Akad. Wetensch. Amsterdam, Proc. 12. p. 774, April 28, 1910.] G. E. A.

736. *Thermomagnetic Properties of Elements.* **H. E. J. G. du Bois** and **K. Honda.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 584–602, March 24, 1910. Communication from the Bosscha Laborat.)—An investigation undertaken to judge whether Curie's conclusions admit of the extensive generalisation given to them. The torsion balance method combined with a non-uniform field was adopted, and the elements are classified as paramagnetic and diamagnetic, each of these groups being subdivided into three others according as the susceptibility is constant, increases or decreases with heating. The most remarkable properties are shown by tin; if the diamagnetic grey tin is slowly heated, at 32° the specific susceptibility (−0·29) changes almost suddenly (like the density), and at 35° passes through zero. Further heating continuously increases the susceptibility, so that at about 50° the value (+0·08) for paramagnetic tetragonal tin is reached, which afterwards remains practically constant. At the melting-point (238°) a discontinuity from +0·08 to −0·04 takes place, the diamagnetic liquid metal remaining nearly unchanged. The results evidently undermine the experimental starting-points of Langevin's theory. G. E. A.

737. *Effect of Longitudinal Stress on Magnetisation of Rocks.* **R. Otani.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 12. pp. 190–197, Jan., 1910.)—A

study of the change of intensity of magnetisation caused by mechanical compression in the direction of magnetisation. In the magnetometric method employed the coils were fixed vertically to a stone pillar; the specimens tested were prisms of square section about 20 cm. × 2·9 cm.², and the compressing apparatus consisted of a simple lever and set of weights, the maximum stress employed being over 16 kg./cm.². Eight different kinds of volcanic rock from localities in Japan were tested, and in all cases the intensity of magnetisation decreased with increasing pressure, the field being constant. The numerical value of $\partial I/I$ lay between 1/10 and 1/100, and the ratio decreased with increase of field. The susceptibility ranged between 0·002 and 0·006. G. E. A.

738. *Magnetic Properties of the Two Kinds of Ions of Oxygen.* **Miss D. B. Pearson.** (Cambridge Phil. Soc., Proc. 15. No. 4. pp. 373–374, Jan. 31, 1910.)—Oxygen, ionised by passage through a long tube lined with uranium oxide, was passed between the poles of a strong electromagnet and then into a Faraday cylinder connected to a Dolezalek electrometer, to discover whether the magnetic field effects a separation of the ionised oxygen into its positive and negative constituents. No certain indication of any such effect could be observed with a magnetic field of 6000 gauss. G. E. A.

REFERENCES.

739. *Radiation from an Electron receiving any Impulse.* **L. Silberstein.** (Ann. d. Physik, 31. 4. pp. 823–836, March 15, 1910.)—An analytical paper obtaining expressions for the radiation starting from a spherical electron whose velocity is suddenly changed by an impulse. A number of cases are considered, including that of the sudden acquisition by the electron of the speed of light when starting from rest. [See Abstract No. 459 (1910).] E. H. B.

740. *The Charge of the Electron.* **J. Perrin.** (Phil. Mag. 19. pp. 438–439, March, 1910.)—A note in answer to a paper by Millikan [see Abstract No. 411 (1910)]. The author points out that his work is free from the objections therein advanced. [See Abstracts Nos. 1816 and 1821 (1908).] T. P. B.

741. *Shape of Beams of Canal Rays.* **J. A. Orange.** (Cambridge Phil. Soc., Proc. 15. 4. pp. 334–336, Jan. 31, 1910.)—Further experiments, which confirm the view [see Abstract No. 426 (1910)] that the *constituent* canal-*rays* are straight. A. D.

742. *Electric Discharge and One-fluid Theory.* **F. E. Nipher.** (Acad. Sci. St. Louis, Trans. 19. 1. pp. 1–20, 1910.)—An account of an examination of electric discharges illustrated by photographs, the evidence being considered by the author in favour of the one-fluid theory of electricity. E. H. B.

743. *Sensibility of Barretter Arrangements.* **H. Zöllich.** (Phys. Zeitschr. 10. pp. 899–902, Nov. 22, 1909.)—A theoretical consideration as to how the greatest sensibility may be obtained, using a Wheatstone bridge arrangement with single barretter. L. H. W.

744. *Secular Variation of Magnetic Elements.* **A. Angot.** (Comptes Rendus, 150. pp. 568–569, Feb. 28, 1910.)—From the reduction of the magnetic observations of the Paris station of Val Joyeux it is found that the horizontal component steadily increased from 1901 to 1907, and it is now definitely decreasing in value from year to year. Most of the other elements show variations of an opposite sign for the same period, a table being given of the details for the nine years 1901–1909. C. P. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

745. *Nickel Wire Resistance Furnaces.* **R. Lorenz** and **G. v. Hevesy.** (Zeitschr. Elektrochem. 16, pp. 185–190, March 15, 1910.)—The nickel wire should be laced, not merely spun, with asbestos; if the tubular furnace consists of metal, the metal should be wrapped with asbestos paper. On the outside this nickel heater should be tightly wound with asbestos cord, and the body be provided with two concentric jackets, best of glazed porcelain. The object is to keep out the oxygen. Nickel appears to be oxidised in the same way as copper is according to Heyn, the oxide forming a eutectic alloy in the metal. Heating up to 700° C. is borne without noticeable oxidation. At higher temperatures the oxidation becomes pronounced, and at 1000° C. ordinary nickel furnaces only last a day or two. When nickel heater-coils are heated for many hours and afterwards tested for resistance at 17° C., the resistance appears diminished by about 1 per cent., provided the temperature has not exceeded 700° C.; the diminution is probably due to the expulsion of occluded gases. When the temperature of 750° C. has been exceeded, the resistance is afterwards found to be much increased, and more than 50 per cent. of oxide was detected in such wire. Several furnaces for temperatures up to 1200° C. are described, and reference is made to Le Blanc [compare Abstract No. 2184 (1909)]. H. B.

746. *Preparation of Silundum.* **S. A. Tucker, H. F. Kudlich,** and **E. M. Heumann.** (Amer. Electrochem. Soc., Trans. 16, pp. 207–218; Discussion, pp. 213–215, 1909.)—The authors describe various experiments made in carborundum furnaces under different conditions; analyses of the products are not mentioned. The furnaces were built up of firebricks; carbon plates (made of grainy carbon) were placed vertically face to face between the horizontal carbon electrodes, which were surrounded by the charge, and plates and rods of carbon, to be converted into silundum, were embedded in the charge. The charge consisted either of a mixture of sand and carborundum (Tone's reactions: $SiO_2 + 2SiC = 3Si + 2CO$) or of sand and carbon ($SiO_2 + 2C = Si + 2CO$); the latter reaction is preferable, as the materials are cheaper. The best results were obtained with the latter reaction when the furnace was not covered, so that the gases could escape and burn all over the surface. It would appear that the silicon vapours penetrate into the carbon and convert it into a hard, heavy, grey or greenish mass, whose resistance decreases at higher temperature. According to **F. J. Tone** (*discussion*), Bölling's silundum is essentially carborundum, of which it contains from 96 to 99·5 per cent. **J. W. Richards** thought that carbon and silicon acted upon one another in the state of vapours. H. B.

747. *Electric Smelting of Copper Ores and Intermediate Products of Copper Works.* **W. Borchers** and **W. Wolkow.** (Metallurgie, 7, pp. 99–102, Feb. 22, 1910.)—Some years ago Borchers obtained very favourable results when smelting copper ore in a small electric furnace, and he therefore asked metallurgists to supply him with materials for similar experiments. The paper is a report on experiments made by Wolkow, also at Aachen and with a small furnace, with an acidic copper ore, rich in silica, containing 8 per

cent. of copper, 55 of silica, 12 of CaO, 6 of Fe_2O_3, 7 of Al_2O_3, 6·8 of MgO, and 8 of sulphur. The ore was easily melted, without addition, in an arc furnace. The ore should be smelted to a matte, the matte roasted, and the product electrically smelted again mixed with about the same amount of ore. There were hardly any copper losses from volatilisation and dust. H. B.

748. *Preparation of Potassium Manganate by Fusion.* **P. Askenasy** and **S. Klonowski.** (Zeitschr. Elektrochem. 16. pp. 104–114, Feb. 1, 1910. Inst. f. physik. Chemie u. Elektrochemie d. techn. Hochschule, Karlsruhe. Dissertation by **S. Klonowski**.)—The potassium manganate to be used in the technical electrolytic preparation of permanganate must be free of compounds like chlorides, nitrates, and sulphates, which would destroy the passivity of the iron anodes. Chlorates and nitrates must hence not be used as oxidising agents in the fusion of manganese dioxide and pure potash. The authors discuss the temperatures and air (or oxygen) pressures suitable for this fusion. Ordinary mixtures of dioxide and potash are inclined to sinter, and thus to prevent the access of air and the introduction of water-vapour; these troubles are overcome by heating the mixture first for several hours up to 250°, and afterwards powdering the product. The yield of manganate is best at 600° in air, in oxygen at a higher temperature. A considerable amount of manganate is already formed at 240°; at 880° the yield is lower. This fall in the yield is due to a decomposition of the manganate if the partial gas pressure sinks below a certain value. Above 620° decomposition again results. Manganese oxide Mn_2O_3 substituted for the MnO_2 behaves similarly in this respect. The authors agree with Haber and Bruner [see Abstract No. 892 (1905)] that potassium manganate, K_2MnO_4 is reversibly decomposed into manganite K_3MnO_3 and oxygen, but stable when in solid solution in the manganite, which is itself stable. H. B.

749. *Electrolytic Preparation of Potassium Permanganate.* **P. Askenasy** and **S. Klonowski.** (Zeitschr. Elektrochem. 16. pp. 170–176, March 1, 1910.)—Having studied the preparation of potassium manganate by fusing manganese dioxide with caustic potash [see preceding Abstract], the authors investigate the electrolytic oxidation of the manganate solution which was first adopted by the Chemische Fabrik Schering with diaphragm, and is now applied by Schuckert and Co. after J. Hess and B. Fraass without diaphragm. The authors use electrodes of iron (kathode a cylinder) and also of Pt with and without diaphragm; the evolution of oxygen in diaphragm cells is considerable. In cells without diaphragms there is reduction at the kathode, which is small, however, and manganese dioxide makes the electrolyte turbid. When the current density is diminished at the kathode, this dioxide adheres to the kathode. The authors recommend that electrolysis be carried out at 80° C. without diaphragm, with a kathode density of 85 amps./dm.², a ten times smaller anode density, an electrode distance of 15 or 20 mm., and a current of 2·8 volts; 20,000 amp.-hours are required per 100 kg. of manganate, and 0·7 kw.-hours per kg. of permanganate. H. B.

750. *Physico-Chemical Studies on Tin.* VIII. **E. Cohen.** (Zeitschr. Phys. Chem. 68. 2. pp. 214–231, Nov. 9, 1909.)—The author has confirmed an observation made by Haslinger in 1908 "On a New Form of Tin Plague," and attempted its explanation. The phenomena, first noticed as a development of a fine crystalline structure on the tinned surface of an air-compressor, can be obtained on the surface of sheet tin and tin-foil by "infection," and

occurs at all temperatures up to 184° C. It is therefore quite a distinct change from the formation of grey tin (the usual tin plague), and from the conversion of rhombic into tetragonal tin occurring at 161° C. Finally the decay was ascribed to the mechanical work put upon the tin having produced a metastable condition, from which the material tends to revert at all temperatures, the conversion being accelerated by heating and by a process of infection, *i.e.*, by being in contact with material in which the change has commenced. The phenomenon, which can probably occur in all severely strained metals, has been called "Mechanical Decay" (Forcierkrankheit).

F. C. A. H. L.

751. *Solid Solutions of the Elements.* **W. Guertler.** (Zeitschr. Phys. Chem. 68. 2. pp. 177–208, Nov. 9, 1909.)—The author discusses the relations existing between solid and liquid solutions, between isomorphism and crystalline shape, and the extent to which the mixed crystals in metallic alloys can be regarded as crystalline solid solutions. Solid solutions are exactly parallel to liquid solutions; they are isomorphous. On the other hand, the term "mixed crystals" indicates an isomorphism of crystal form. The existence of diffusion phenomena in the solid and the development of heat during the formation of solid solutions are exactly analogous to similar effects observed in liquid solutions. Recent researches show that alloys free from solid solutions do not exist. The influence of crystal form on the formation of mixed crystals appears to be very slight, since examples of two isomorphous elements which form continuous series of solid solutions with a third element and yet show very little mutual solubility in the solid are fairly numerous. On the other hand, cases are known of two elements of different crystal form giving rise to a continuous series of solid solutions. The view that mixed crystals are not known between elements and compounds is erroneous, many examples of such mixed crystals being known, notably Fe—Fe_3Si and γFe—Fe_3C. The same relations with regard to the formation of mixed crystals exist here as exist in the case of the elements. In the formation of these solid solutions the properties which distinguish the compound from the components are gradually lost, rendering difficult the investigation of the formation of compounds in such series as Cu—Zn.

F. C. A. H. L.

752. *Crystalline Structure of Iron at High Temperatures.* **W. Rosenhain and J. C. W. Humfrey.** (Roy. Soc., Proc. Ser. A. 83. pp. 200–209, Jan. 7, 1910.)—The authors have carried out some preliminary experiments, with a view to studying the modes of deformation of metals at high temperatures, on a commercially pure iron (transformer sheet) containing less than 0·25 per cent. total impurities. Oxygen was removed by heating the metal in pure hydrogen at 900° C. Derived differential curves showed arrests on heating, at 770° and 940° C., and on cooling, at 904° and 768° C. By means of a specially designed apparatus it was possible to electrically heat polished specimens *in vacuo*, and, when at the desired temperature, to strain them by means of a coiled spring. The temperature, which varied considerably along the specimen, being low at the ends and high in the centre, was indicated by the fusion of minute particles of various salts placed on the back of the specimen. Microscopic observations were made on specimens which had been heated without and with straining. Unstrained specimens showed, in the central hottest portions, superposed upon the regular ferrite structure more regular and larger crystals exhibiting well-defined twinning similar to

the γ-iron structure observed in Ni-steels. The strained specimens showed at the cold ends an unaltered surface, but as the temperature increased the ferrite crystals were cross-hatched with slip bands, increasing in intensity until at a certain point a sharp line of demarcation appeared, beyond which the slip bands cease and the surface of the metal becomes covered with double boundaries as in the unstrained specimens. Nearer the hottest portion of the specimen minute slip bands were found. These became regular and well-defined in the centre and hottest region of the specimen. Since metals without critical points, like Cu and Pt, do not show this phenomenon, the discontinuity of surface in the case of iron is associated with the existence of the three allotropic modifications α, β, and γ in the various temperature-ranges, the sharp line of demarcation marking the α/β change. When the stress was high enough to break the specimen, fracture always occurred on the colder side of this line and not in the region of highest temperature as observed in the cases of Cu and Pt. The results indicate that as the temperature increases α-iron becomes weaker and shows an increased tendency to slip. As a result of α/β change an increase of tenacity occurs in spite of the weakening effect of heating, and the absence of slip bands proves that the material has been hardened by the transition. The truly crystalline nature of γ-iron is indicated by the slip bands tending to follow the steps of the twin crystals. The authors conclude that up to 1100° C. iron behaves as a crystalline aggregate, undergoing plastic deformation by a process of slip on the cleavage planes of the crystals, which may or may not be accompanied by mechanical twinning. Iron exists in three modifications possessing widely different mechanical properties, the temperature-ranges in which they exist being consistent with the view of their identity with the α, β, and γ forms of Osmond and Roberts-Austen. Although it exists at a higher temperature, β-iron is both harder and stronger than α-iron. The γ-iron existing in pure iron at high temperatures is similar in structure and properties to the γ-iron of alloy steels. F. C. A. H. L.

753. *Decarburisation by Means of Gaseous Oxidising Media.* **H. Becker.** (Metallurgie, 7. pp. 41–59, Jan. 22, 1910.)—Numerous experiments on the decarburisation of tempered white cast-irons by heating to high temperatures in atmospheres consisting of mixtures of CO and CO_2 in various proportions are described. The results show that the removal of carbon increases with the CO_2-content of the gases and with the temperature. The velocity of reaction limits the temperatures to between 900° and 1000° C., and at these temperatures mixtures of CO and CO_2 containing from 28 to 24 per cent. CO_2 have no appreciable oxidising effect on the iron, and are therefore available as gaseous decarburisation media. F. C. A. H. L.

754. *Structure of Steel at High Temperatures.* **A. Baykoff.** (Rev. de Metallurgie, 6. pp. 829–884, July, 1909. Metallurgie, 6. pp. 743–745, Dec. 8, 1909. Abstract.)—H. le Chatelier's definition of austenite, viz., that it consists of a solution of carbon in γ-iron, stable within certain temperature limits, is probably the most correct one. Pure austenite is never met with at ordinary temperatures, since, on account of the difficulty of attaining a sufficiently rapid quenching, it is usually associated with martensite, troostite, and cementite. In alloys containing large quantities of Ni and Mn, which are non-magnetic, austenite is stable at the ordinary temperature, but the purest austenite is due to Maurer, who quenched an alloy containing 2 per cent. carbon and 2 per cent. Mn in ice water from 1100° C. The quenched

metal is non-magnetic and possesses a polyhedral microstructure typical of the non-magnetic steels. The author has observed the structure of pure austenite by heating steels (containing from 0·12 to 1·94 per cent. C.) in an atmosphere of dry hydrogen to 1120° C. The hydrogen was replaced by hydrochloric acid gas for a few seconds and then hydrogen passed through the apparatus during cooling. Microscopic examination of the samples showed that they possessed a polyhedral crystalline structure with a distinct tendency to twinning. Examination of a steel with 0·5 to 0·8 per cent. carbon etched at 870° C. in the above manner also showed an austenitic structure. The martensitic structure does not, therefore, represent the condition of the steel at any particular temperature, but is due to a mechanical change of form brought about by quenching. F. C. A. H. L.

755. *Fusion Diagram of Nickel-Carbon Alloys.* **K. Friedrich** and **A. Leroux.** (Metallurgie, 7. pp. 10–13, Jan. 8, 1910. Communication from the Jubiläums-Stiftung d. deutsch. Industrie.)—By means of cooling-curves and micrographs the authors have investigated the nickel-carbon alloys up to a content of 2·6 per cent. carbon, but point out that the results are not to be regarded as representing complete equilibrium since the alloys contained 0·2 to 0·6 per cent. iron, and on account of the instability of the high-carbon alloys rapid cooling was resorted to. Carbon lowers the melting-point of Ni (1451° C.) until a eutectic point is reached between 2 and 2·5 per cent. carbon, the eutectic line being situated between the temperature limits 1307° and 1318° C. Nickel holds carbon in solid solution to the extent of about 1 per cent. Microscopic examination confirms the thermal results; a 2·6 per cent. carbon alloy shows clearly the presence of primary crystals of the carbon carrier, possibly a carbide of Ni, and the quenched alloys have the same structure as the slowly cooled alloys, confirming the absence of critical points in the cooling curves similar to those observed in the iron-carbon alloys. F. C. A. H. L.

756. *Influence of Antimony and Tin on the Iron-Carbon System.* **P. Goerens** and **K. Ellingen.** (Metallurgie, 7. pp. 72–79, Feb. 8, 1910.)—Swedish pig-iron containing 3·66 C, 0·15 Si, 0·2 Mn, 0·008 S, and 0·02 P in per cent. was melted in magnesia-lined carbon crucibles and heated to 1350° C., when Sb or Sn was added in order to make ternary alloys containing up to 60 per cent. Sb in one series and 11 per cent. Sn in the other. Cooling curves of the melts were taken, and the samples were afterwards subjected to microscopic examination. *Iron-Antimony-Carbon.*—The addition of Sb to iron-carbon alloys containing about 3·5 per cent. carbon lowers the temperature of both the primary separation of austenite and the solidification of the binary eutectic, until at 5 per cent. Sb the two curves meet at 1090° C., and from this point onwards two sets of crystals separate primarily. At about 950° C. a new line of points is introduced, this corresponding with the solidification of the ternary eutectic. The temperature of the pearlite change (700° C.) is unaffected, but the magnitude of the change decreases with increase of Sb. The microstructures of the alloys confirm the above views and show three constituents, viz., pearlite, cementite, and antimonide of iron. The antimonide is differentiated from the cementite by turning grey on long etching with picric acid and by not colouring so rapidly under heat tinting. *Iron-Tin-Carbon.*—This series is very similar to the latter, but is somewhat complicated by the existence of a limited liquid miscibility in the Fe-Sn system. A ternary eutectic is formed at about 940° C., and the pearlite

change-point is unaffected. The microstructure reveals the three constituents, pearlite, cementite, and stannide of iron, which are differentiated in exactly the same manner as in the Fe-Sb-C alloys. F. C. A. H. L.

757. *Influence of Pressure on Solubility.* **E. Cohen and L. R. Sinnige.** (Zeitschr. Phys. Chem. 67. 4. pp. 432–445, Sept. 8, 1909.)—A description of experiments made to determine the influence of pressure on the solubility of $CdSO_4.8/3H_2O$ and $ZnSO_4.7H_2O$ at 25° C. The results are given in the following tables:—

1. Solubility of $CdSO_4.8/3H_2O$.

Pressure in Atmos.	Temperature.	Gm. $CdSO_4$ in 100 gm. of Water.	Solubility at 25° C.
1	25·0°	76·80	76·80
500	25·0	77·85	77·85
500	24·6	78·08	78·15
1000	26·0	78·96	78·77
1000	25·6	78·79	78·68

2. Solubility of $ZnSO_4.7H_2O$.

Pressure in Atmos.	Temperature.	Gm. $ZnSO_4$ in 100 gm. of Water.	Solubility at 25° C.
1	25·0°	57·95	57·95
500	26·0	58·43	57·92
500	25·8	58·32	57·91
1000	25·8	57·95	57·55
1000	25·8	57·95	57·55

F. E. S.

758. *Kinetics of Rapid Chemical Reactions and of Ionic Reactions. Oscillographic Investigation.* **D. Reichinstein.** (Zeitschr. Elektrochem. 15. pp. 734–740, Oct. 1, 1909. Paper read before the 16. Hauptversamml. d. Deutsch. Bunsen-Gesell., Aachen, May, 1909.)—When a metal capable of yielding primary ions is used as anode in a solution, and the current passed, the ions so formed can undergo (in some cases) interaction with the anions present to form complex ions. It is the purpose of the present paper to describe a method of studying the velocity of this chemical reaction, *e.g.*, $Ag + 2CN' = Ag(CN)_2'$. Assuming that the primary formation of the kathion takes place with a velocity much greater than that of the ionic combination, then on closing the circuit there will be a formation of ions the concentration of which will gradually diminish owing to the chemical reaction between the ions. On this assumption the author develops an equation which shows that the polarisation potential is a time function having a logarithmic-exponential form. The greater the velocity of the chemical reaction the sooner is the asymptotic value reached. To obtain a method of measurement the author studies the decay of the polarisation potential on breaking the circuit after the metal has been anode for a short time. The author describes an apparatus by means of which the current is automatically made and broken, and the potential is photographically recorded. The reactions studied by the

author are the formation of $CuCN'$, $Ag(CN)'_2$ and the disappearance of H' at a lead electrode. The formation of the complex silver cyanide ion takes place with much greater velocity than the complex copper cyanide ion. A. F.

759. *Equation of State for Liquids at High Pressures.* **O. Tumlirz.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 208–241, Feb., 1909.)—On integrating at constant T the former of the two equations previously given by the author [see Abstract No. 622 (1901)], and denoting by P some unknown function of T, the following equation is obtained: $(p + P)(v - a) = T/12{\cdot}225m$. This equation is of the same form as that of van der Waals, and differs from the latter only in that the magnitude P, which may be termed the internal pressure, is solely a function of T. When this equation is tested by means of measurements made on water at all pressures from $p = 1$ to $p = 8{,}000$ atmos., it is found that the difference between the observed and calculated values increases with the pressure and reaches the value 0·66 per cent. Better agreement between the observed and calculated values is obtained by replacing the factor of T, namely, $1/12{\cdot}225m$ by another constant R, which, together with a, may be determined from the experimental data. Taking the mean values of a and R, the above expression gives values which at low pressures vary from the observed values by as much as 0·8 per cent., but which are in good agreement at high pressures. It is also found to hold for methyl, ethyl, allyl, and propyl alcohols, ether, acetone, phosphorous chloride, carbon disulphide and ethyl chloride, bromide and iodide. Above 3000 atmos. it is found that the volume of 1 mol. approaches the limiting value of a calculated for 1 mol. (a_m), so that a_m is the volume in c.cm. of 1 mol. at infinitely great pressure, this volume being independent of the temperature. If the molecular weights are divided by these volumes, the following densities of liquids at infinitely great pressures are obtained:—

Water	1·476	Acetone	1·180
Ethyl alcohol	1·146	Phosphorous chloride	2·228
Methyl alcohol	1·162	Carbon disulphide	1·878
Propyl alcohol	1·155	Ethyl chloride	1·339
Allyl alcohol	1·210	Ethyl bromide	2·152
Ether	1·011	Ethyl iodide	2·828

The values of P for the above liquids are given for different temperatures, and the above considerations are extended to the study of (1) isothermal and adiabatic compressibility; (2) variation of the two specific heats with the pressure; (3) the velocity of propagation of sound; (4) the evolution of heat on compression; and (5) the question of a max. density: for such max. density to be possible, the internal pressure P must increase with rise of temperature, and the increase must be sufficiently great to fulfil the condition represented by the equation $T(\partial P/\partial T)_v > P$. T. H. P.

760. *Determining very Small Ozone Concentrations. Efficiency of Goldstein's Ozoniser at High Dilutions.* **W. Hallwachs.** (Ann. d. Physik, 30. 8. pp. 602–606, Nov. 4, 1909.)—The author resumes his experiments on the apparently strong absorption of slow electrons by ozone [see Abstract No. 1675 (1907)]. Very small ozone concentrations can be accurately determined by the photoelectric method, as the absorption of light by ozone is extraordinarily strong near 258 $\mu\mu$ (E. Meyer). The quartz-mercury lamp

used for this purpose is described, but not illustrated. The same applies to the ozoniser of Goldstein, which has been supposed to transform oxygen completely into ozone. A measured quantity of pure oxygen was admitted into a Geissler tube surrounded by a liquid-air jacket. The ozone pressures found (determined as indicated) were always far too small; some ozone may have been absorbed by the walls or by the electrodes. But in any case no conclusions as to the absorption coefficients of electrons were possible, and the experiments were hence abandoned. H. B.

761. *Vapour Tension of an Electrified Liquid.* **Gouy.** (Comptes Rendus, 149. pp. 822–825, Nov. 15, 1909.)—On the basis of the relations established in the author's previous paper [see Abstract No. 2155 (1909)], the effect of electrification of an electrolytic solution on its vapour tension is calculated; and it is shown that if one consider merely the surface layer as more concentrated than the interior, a correct expression is arrived at for the diminution of the vapour tension due to the charge alone. A. F.

762. *Influence of Ingot Size on Segregation in Steel.* **H. M. Howe.** (Amer. Inst. Mining Engin., Bull. 34. pp. 909–912, Oct., 1909.)—The author has previously deduced that the tendency of segregation in ingots for this to increase with their size is liable to be more or less masked by the effect of other variables in ingots less than 16 in. thick. Curves are plotted showing the percentage enrichment in carbon, phosphorus, and sulphur in relation to ingot size; and the data in connection with these curves are to be published later. Carbon segregates least, and sulphur most. In an acid open-hearth test ingot $\frac{1}{4}$-in. thick some of the metal had been enriched to about 8 per cent. carbon, *i.e.*, white cast-iron, with actually 4·8 per cent. carbon in the eutectic areas. There was only 1·08 per cent. carbon near the outer surface, so that even very small ingots may be greatly enriched by segregation. Photomicrographs taken from this ingot are given. F. R.

763. *Formation of Nitrogen-Lime.* **F. Foerster** and **H. Jacoby.** (Zeitschr. Elektrochem. 15. pp. 820–834, Nov. 1, 1909.)—The resumed experiments [compare Abstracts Nos. 780, 782, 1970 (1907)] confirm on the whole the conclusions of Bredig, Fränkel, and Wilke. Calcium carbide binds nitrogen energetically above 1000°; the reaction begins at 800° and lower, but is soon arrested at lower temperature. The addition of a few per cent. of $CaCl_2$ and also of CaF_2 (proposed by F. Carlson) facilitates the fixation of the nitrogen, probably by softening the surface layer of cyanamide formed, which keeps the nitrogen off. The experiments are made in gas-heated Heraeus furnaces with 8 gm. of substance. The addition of more than 2 per cent. of CaF_2 and long-continued heating with it are not recommended. The mass spontaneously heats itself when nitrogen is being absorbed; this spontaneous heating was less noticeable in the presence of CaF_2 than with pure carbide and in the presence of $CaCl_2$. The action of the CaF_2 is not fully understood. A little cyanide is also formed during the reactions, but it did not in any case amount to 0·1 per cent. H. B.

764. *Dielectric Constants of Solid Mixtures.* **E. Rudolfi.** (Zeitschr. Phys. Chem. 66. 6. pp. 705–732, June 8, 1909. Chem. Laborat. u. Physikal. Inst. d. Univ., Giessen.)—The dielectric constants of ten systems of binary mixtures having naphthalene as one component, were determined. The measurements were made in a modification of Drude's apparatus, using

thiophene-free benzene (D.C. 2·26) and mixtures of benzene and acetone (D.C. 2·96, 8·50 respectively) as comparison liquids. The melting-points of mixtures of each pair of substances were determined, and from these the equilibrium diagram was constructed, and the constitution of the solid material deduced. From the dielectric-constant measurements it is considered that: (1) When the constituents form in the crystalline state, a conglomerate, the dielectric constant can be calculated from the formula D.C. $= \sqrt{K}/d$, where d = density. (2) This holds also when the bodies form mixed crystals. (3) It is not evident from the systems examined whether the dielectric constant of compounds can be calculated from the dielectric constants of the components. F. J. B.

765. *Molecular Attraction.* VIII. **J. E. Mills.** (Journ. Phys. Chem. 13. pp. 512–581, Oct., 1909.)—The equation $(L - E)/(\sqrt[3]{d} - \sqrt[3]{8D}) =$ constant [compare Abstracts Nos. 1219 (1907), 1170 (1908)] has been further tested by means of accurate, unpublished data obtained by Young. For the great majority of the substances considered the constancy of the above expression is very approximate, excepting at 0° (80° for bromobenzene and iodobenzene) and at temperatures near the critical temperature. Some of the deviations observed in a few cases are doubtless due to errors in the determination of the physical constants. Apart from abnormal cases, the law is more accurate than the data available for its verification. The law can be expressed in the simpler form, $\lambda s =$ const., where s is the distance between the molecules; or, in words, the internal heat evolved as the molecules approach each other, multiplied by the distance apart of the molecules, is a constant. T. H. P.

766. *Internal Heat of Vaporisation.* **J. E. Mills.** (Amer. Chem. Soc., Journ. 31. pp. 1099–1180, Oct., 1909.)—The author has calculated the values of the internal heat of vaporisation for a number of compounds by means of his own formula [Abstract No. 1219 (1907)] and also of the formulæ of Clausius, $\lambda = 0{\cdot}000081888(T dP/dT - P)(V - v)$, and of Crompton, $\lambda = CRT \log (V/v)$ [Abstract No. 1286 (1901)]. The results obtained in the three cases are in satisfactory agreement, but at low vapour-pressures the equation given by Crompton is not exactly true. Certain necessary consequences of the three equations are deduced and discussed. T. H. P.

767. *Relationship between Density and Ionisation of Aqueous Salt Solutions.* **S. Tereschin [Terešin].** (Deutsch. Phys. Gesell., Verh. 12. 2. pp. 50–58, Jan. 30, 1910.)—It is shown that when the constant A, of Heydweiller's equation [Abstract No. 942 (1909)] is resolved into two moduli by the method already described [Abstract No. 1808 (1909)], linear relations exist between the moduli and the atomic weight, (1) in the case of the univalent kathions Li, Na, K, Cu, Rb, [Ag], and Cs; (2) in the case of the divalent kathions Mg, Ca, [Zn], Sr, Cd, Ba; and (3) in the case of the univalent anions [F], Cl, Br, and I. The elements shown in brackets are those which show the largest deviations from the linear law. These observations are regarded as an important confirmation of Kohlrausch's theory of a "watery atmosphere" round the ions. T. M. L.

768. *Heat of Dilution of Zinc Amalgams.* **W. D. Henderson.** (Phys. Rev. 29. pp. 507–515, Dec., 1909.)—The author has applied the thermodynamic equation $E = H/nF + T . dE/dT$ to the measurement of the heat of dilution of zinc amalgams. Cells of the type: Conc. Zn-amalgam | solution of $ZnSO_4$ | dilute Zn-amalgam were set up and the e.m.f. measured at different tem-

peratures. Assuming that the above equation holds, it was computed that the heat of dilution for the entire series of amalgams is negative, and varies from a value that is nearly or quite negligible for a concentration of 0·5 per cent. to about 10,000 joules per gm.-ion for a concentration of 8 per cent. In the region of 2 per cent. amalgams a marked change occurs in the constitution of the amalgams. A. F.

769. *Reduction of Zinc by Mercury, and E.M.F. of Zinc Amalgams.* **J. L. Crenshaw.** (Journ. Phys. Chem. 14. pp. 158–188, Feb., 1910.)—If a mixture of two metals be brought into a solution of their salts, one metal will go into solution while an equivalent amount of the second will be precipitated until the equilibrium condition is reached. This condition in the case of mercury, zinc sulphate, and water has been investigated by the author. Measurements of the e.m.f. of zinc amalgams at 25° extending from the saturated amalgam to a dilution of 1 part of zinc to 1 billion parts of mercury were made. It was found that there is a region between 2 gm. of zinc to 1000 gm. of mercury, and of 1 gm. of zinc to 10 million of mercury, where the potentials of any two amalgams conform to the requirements of the gas laws. Beyond this dilution the potential fell off so rapidly with the time that no accurate measurements could be taken, which indicates that the reaction $Zn + Hg_2 \rightleftarrows Zn^{\cdot\cdot} + 2Hg$ is a reversible one and that a definite equilibrium is established in the system: mercury, zinc sulphate, water. A. F.

770. *E.M.F. of the Hydrogen Cyanide Cell.* **R. Naumann.** (Zeitschr. Elektrochem. 16. pp. 191–199, March 15, 1910.)—The author has carried out measurements of the e.m.f. of various $H_2 - C_2N_2$ cells, in which the current-yielding reaction is $H_2 + C_2N_2 + aq = 2HCN\ aq$. The partial pressures of hydrocyanic acid in the solutions used have also been investigated. From these measurements he has calculated by means of the new thermodynamic theorem of Nernst that the equilibrium of formation of hydrogen cyanide in the gaseous state is represented by $\log \frac{[H_2][C_2N_2]}{[HCN]^2} = -\frac{2849}{T} - 2{\cdot}24$. It follows therefore that the chemical constant (−2·24) is considerably higher in the case of hydrogen cyanide than in the case of the halogen hydrides (−1·2 to −1·4). A. F.

771. *Cadmium Amalgams and the Weston Normal Cell.* **F. E. Smith.** (Phil. Mag. 19. pp. 250–276, Feb., 1910. Paper read before the Physical Soc., Oct. 22, 1909. Abstracts in Elect. Engin. 44. p. 618, Oct. 29, 1909. Electrician, 64. pp. 943–946, March 18, 1910.)—The exact constitution of cadmium amalgams is doubtful, but there is no doubt that the electromotive properties of the amalgams depend on whether one or two phases are present. When, by increasing the temperature, a solid amalgam is converted into a mixture of liquid and solid phases, there is an immediate change in the electromotive temperature-coefficient of the amalgam, and a similar change results when the co-existing phases are changed entirely into the liquid state. With a two-phase stable amalgam the e.m.f. does not depend on the relative amounts of the two phases. Hence, stable amalgams containing different percentages of Cd, but possessing the two phases, have the same e.m.f. towards a cadmium sulphate solution. With amalgams all solid or all liquid, the e.m.f. varies with the Cd-content. The objects of the present investigation were: (1) To trace the cause of the electromotive differences, which sometimes existed, and which were sometimes absent, between 10 and 12·5 per cent. amalgams. (2)

To determine the limits of temperature between which amalgams of various concentrations could be usefully employed. (3) To explain the abnormal e.m.f.'s of cells made by various observers when the amalgams contained from 12·5 to 14 per cent. of Cd. (4) As the recent International Conference on electrical units and standards specify a 12·5 per cent. amalgam, it was important to decide whether the limits of temperature (0–40° C.) specified, required amending or not. The method consisted in directly measuring the difference of e.m.f. between two amalgams in contact with a saturated solution of cadmium sulphate. The materials in contact with the amalgams were identical with those used in the Weston normal cell, and any amalgam could at any time be used as the negative element of such cell. Each of the glass vessels used to form the cells had four vertical limbs connected by means of a tubular cross-piece. A 10 per cent. amalgam was placed in the bottom of one of the limbs, and amalgams of different percentages of Cd were placed in two of the other limbs; in the remaining limb mercury and a depolariser consisting of a paste of mercurous sulphate and cadmium sulphate crystals and solution was introduced. The cell was then filled and sealed in the usual manner. Such a cell consists of one positive element and three negative ones, one of which consists of a 10 per cent. amalgam, and consequently a number of different measurements could be made with it. The following series of measurements of e.m.f. were made: (1) Of cells containing amalgams with from 1 to 20 per cent. of cadmium, and at temperatures varying from 0° C. to 45° C. (2) At 0° C. of cells containing from 2 to 20 per cent. of Cd in the amalgams, and at intervals of time extending over 4½ months. (3) At 0° C. of cells containing amalgams with from 2 to 20 per cent. of Cd derived from different sources. (4) At 0° C. of cells containing 14 per cent. amalgams, one of which had been slowly cooled from the temperature at which it was completely liquid, and the other rapidly chilled to −50° C., before the cell was made up. (5) At 0° C. of cells containing slowly cooled and chilled amalgams with from 10 to 25 per cent. of Cd. (6) Of cells containing 12·5 per cent. amalgams which had been chilled to varying temperatures, the lowest temperature being −50° C. In (4), (5), and (6) the observations extended over 21–30 days. (7) Of cells containing previously chilled amalgams with from 2 to 25 per cent. of Cd, and at temperatures ranging from 0° to 65° C. With the 17 per cent. amalgams the effects of temperature-changes on the chilled and slowly cooled amalgams were further investigated, the temperatures varying from 0° to 50° C. in one day. (8) With a 10 per cent. amalgam the temperature-coefficient of each limb of a Weston cell was determined, the temperatures ranging from 0° to 30° C. The conclusions arrived at are as follows: (1) Cadmium amalgams of such a composition that if homogeneous they would be completely solid below certain temperatures, may not in a Weston normal cell have that e.m.f. towards a cadmium sulphate solution corresponding to such a solid. The general result is a lowering of the e.m.f. of the cell and is due to lack of homogeneity of the amalgam, the outer shell of which is of low Cd concentration and the centre of the mass of high Cd concentration. Diffusion tends to restore uniformity, and in consequence the cell is unstable for a very considerable time, the e.m.f. rising. (2) When the amalgam is at a temperature near to, but below, the first transition-point, the difference of concentration between the inner and outer parts of the amalgam need be only small to enable the outer shell to be a two-phase system. Owing to the small difference of Cd-concentration throughout the mass, the diffusion process will be slow and the e.m.f. of the cell may remain constant for a very

long time. There is, however, a small difference in e.m.f. between such a cell and one containing a normal two-phase system. (3) Cadmium amalgams of such a composition that, if homogeneous, they would be all liquid above certain temperatures, may not in a standard cell have that e.m.f. toward the solution corresponding to a homogeneous amalgam. In such case the e.m.f. of the cell is higher than usual. The effect is due to the upper part of the amalgam being a two-phase system and the lower part an all-liquid system of less cadmium concentration than the upper part. Diffusion quickly equalises the concentration, and the e.m.f. falls to the normal value. (4) The 12·5 per cent. cadmium amalgam at present used in the Weston normal cell may be completely solid at temperatures below 12° C., and cells containing it may have a higher e.m.f. than normal if used below that temperature. Fortunately, even at temperatures such as 0° C., the amalgam is comparatively near to its first transition-point, and the conditions are similar to those noted in (2). In consequence, except in rare cases, cells containing the 12·5 per cent. amalgam will behave at 0° C. as though they contained an amalgam which was always in a two-phase system at that temperature. (5) As a 10 per cent. amalgam at 0° C. is above its first transition-temperature, this may be used in standard cells at low temperatures. Such cells may also be used at temperatures as high as 51° C. It is suggested that the 12·5 per cent. amalgam in the Weston normal cell be replaced by a 10 per cent. amalgam. T. S. P.

772. *Electrolytically Prepared Explosive Antimony.* **R. C. Palmer** and **L. S. Palmer.** (Amer. Electrochem. Soc., Trans. 16. pp. 79–84, 1909.)—Referring to Gore and to Cohen [see Abstracts Nos. 1205 (1904) and 1971 (1905)], the authors find that explosive antimony is obtained, also in the absence of hydrochloric acid, when 75 per cent. solutions of antimony trichloride in acetone are electrolysed at low current-density and 0° C. The product contains some acetone and is flaky, differing in appearance from the product obtained in the presence of hydrochloric acid. H. B.

773. *Polarisation of Electrodes.* **G. Ercolini.** (N. Cimento, 18. pp. 881–898, Nov.–Dec., 1909.)—The author has examined the variation in polarisation of a voltameter having electrodes of Au, Pt, or Pd immersed in 10 per cent. sulphuric acid, when the sign of the current traversing it is instantaneously changed by means of a Wheatstone bridge arrangement. Gold electrodes are the least, Pd electrodes the most, absorbent. For short periods of charge, the effect of the occlusion with Au electrodes is negligible, but for a longer charge it becomes appreciable, as it is also with Pt or Pd electrodes for much shorter charges. The polarisation caused by a current of given duration when the electrodes are in the normal state, is distinctly different from that produced when the voltameter has been just previously traversed by an equal current, of equal duration but of opposite sign. It is concluded that if two equal currents, due to the same current but of opposite sign, are passed through a voltameter, one immediately after the other, for equal times, $t_2 = t_1$, the polarity resulting at the end of t_2 is of the same sign as that which generates the current passing last, and depends upon the volume effect presented by the electrodes. The changes in the polarity during t_2 are quite different to those during t_1, and depend on the nature of the electrodes. When t_2 does not equal t_1, the resulting polarity depends in value and sign on the relative values of t_2 and t_1, as well as on the nature of the electrodes. The relation $p = P/idt$, where p is the polarisation, and P the e.m.f., is not always correct, but only applies when the e.m.f. is constant. W. H. St.

774. *Alternating-current Phenomena in Aluminium Cells.* **A. H. Taylor.** (Ann. d. Physik, 30. 5. pp. 987–1028, Dec. 14, 1909. Dissertation, Göttingen.)—The author determines the dynamic characteristics of Al rectifiers in solutions of $(NH_4)_2HBO_3$ and also in a Grisson cell with the aid of a Siemens and Halske oscillograph. In the static tests the Al was the kathode. The results suggest a modification of the theory of G. Schulze [compare Abstracts Nos. 1260 and 2120 (1907) and 1205 (1908)]. The surface of the Al will generally become oxidised; between this surface and a slimy skin, consisting of $Al(OH)_3$, a film of gas (essentially oxygen), is formed. The skin accounts for the capacity effect; the valve effect arises, when the film has become conducting under the influence of the electrons emitted by the aluminium oxide as kathode. The gaseous film is not everywhere of the same thickness, and a number of films of various thicknesses may be distinguished and may be regarded as coupled in parallel. The characteristics indicate a lag in the gas discharge in the third quadrant, which is dependent upon the pressure, frequency, and wave-form, and is influenced by the slimy skin. The valve effect diminishes with increasing frequency, while the capacity increases. When the skin is removed by rubbing (with paper) or by shaking, the valve action is improved, and the rectifier cells might be improved by providing for a continuous rubbing of the Al with a soft substance. The author has not observed any deterioration of his cell in the course of time. **G. Schulze** (Ibid. 31. 5. pp. 1058–1062, April 5, 1910.) Schulze points out that the form of cell employed by Taylor was unsuitable and that the latter's conclusions are consequently not justifiable. H. B.

775. *Production of an Adherent Kathodic Diaphragm of Lime by means of Protecting Colloids.* **E. Müller** and **M. Buchner.** (Zeitschr. Elektrochem. 16. pp. 93–96, Feb. 1, 1910.)—Whilst the presence of a small proportion of potassium chromate in the electrolysis of sodium chloride solution produces a considerable diminution in the amount of reduction occurring at the kathode [compare Abstracts Nos. 880 (1898); 1408 (1899); 914, 1156 (1901); 928 (1902)], the influence of calcium chloride in this direction is small when smooth Pt electrodes are employed, but is largely increased by the use of a carbon kathode. When the solution contains small proportions of calcium chloride and calcium hydroxide and a platinised Pt kathode is used, the amount of reduction can be diminished to about 1 per cent. by mixing solution of gelatine, starch, gum arabic, or soluble albumin with the electrolyte. The calcium chloride may be omitted but not the hydroxide, since in the latter case free hypochlorous acid would be formed. The lime which separates at the kathode when one of the above colloids is present in the solution forms an adherent crust which cannot easily be removed by either mechanical or chemical means. Electrodes coated in this way with lime may be employed in the electrolysis of pure sodium chloride solutions, the reduction then remaining inconsiderable. Of the various colloids, wheat starch is recommended especially, as its presence does not lead to frothing of the solution, such as occurs when gelatine is used. T. H. P.

776. *Electrolytic Deposition of Iron.* **A. Pfaff.** (Zeitschr. Elektrochem. 16. pp. 217–228, April 1, 1910.)—When thick deposits of iron are required, high current-density at the kathode must be applied. The author tests three such processes: Merck, concentrated ferrous chloride, 4 amps./cm.², 70° C.; Burgess and Hambuechen, saturated ferro-ammonium sulphate, 80° C., 1 amp./cm.²; H. Lee, ferrous sulphate, saturated cold, with 0·05-N sulphuric

acid, electrolysed at 90° under exclusion of air. He recommends a modified Lee process, 2-N ferrous sulphate with 0·01-N sulphuric acid, 2 amps./cm.², 70° C., removal of hydrogen bubbles by blowing in air. The air supply did not answer for Merck; but the author did not analyse his iron deposits.

H. B.

777. *Liberation of Oxygen during Electrolysis of Hydrochloric Acid with a Platinum Anode.* **G. Pfleiderer.** (Zeitschr. Phys. Chem. 68. 1. pp. 49–82, Oct. 26, 1909.)—When a dilute solution of hydrochloric acid is electrolysed with a fresh Pt anode, and the current is kept constant, the potential rises gradually from about 1·4 to about 1·9 volts, and it is only at the last-mentioned potential that oxygen is given off freely. This phenomenon is doubtless connected with the gradual formation of a layer of platinum oxide on the anode. Both oxygen and chlorine are formed when a dilute solution of HCl is electrolysed, and the relative amounts of these gases liberated under varying conditions have been measured. With constant condition of the electrode and electrolyte, the relationship between the proportion of current, i_2, employed in liberating oxygen, and that used up for other purposes is represented by the equation: $\log i_2 = a \log i_1 + b$, where a and b are constants depending on the condition of the electrode and the nature of the electrolyte. Further, the dependence of the oxygen evolved on the concentration of the HCl is represented, between 0·10 and 1·5-N by the equation: $b = b_0 + 2 \log c$, where c represents the concentration. A theoretical explanation of the results is given, depending on the occurrence of supertension at the electrode.

T. S. P.

778. *Causes of the High Results in the Electrolytic Determination of Zinc.* **E. B. Spear.** (Amer. Chem. Soc., Journ. 32. pp. 533–538, April, 1910.)—It is experimentally shown that the high results obtained in the electrolytic determination of zinc are not caused by the enclosure of liquid, presence of a salt, hydrogen in the deposit, or by the presence of another metal. The true cause is the deposition of zinc oxide or hydroxide with the zinc. From a consideration of the equilibria existing in strongly alkaline solutions of a zinc salt it is shown that the concentration of the zinc ion is inversely proportional to the fourth power of the concentration of the hydroxyl ions, and that consequently it becomes relatively more and more difficult to precipitate zinc as the concentration of the hydroxyl ion is increased.

T. S. P.

REFERENCES.

779. *Ionisation in Lead and Cadmium Acetate Solutions.* **A. Jaques.** (Faraday Soc., Trans. 5. pp. 225–243; Discussion, p. 243, Feb., 1910.)

780. *Influence of Dissolved Gases on Electrode-potential in the System: Silver-silver Acetate, Aq.* **A. Jaques.** (Faraday Soc., Trans. 5. pp. 212–223; Discussion, pp. 223–224, Feb., 1910.)

781. *Potential Differences between Two Electrolytic Solutions.* **H. Pleijel.** (Ark. för Mat. Astron. och Fysik, Stockholm, 5. 14. pp. 1–56, 1909.)—This mathematical paper, which does not lend itself to abstraction, is divided into three parts: (1) in which, with the help of the theoretical considerations of Nernst and of Planck (Wied. Ann. 40. 561, 1890), the general case of the p.d. between solutions of two electrolytes is considered; (2) which deals with special cases and with the numerical calculations, and (3) which treats of the conditions under which the p.d. is zero.

T. H. P.